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THE PLACE OF WINTER FEEDING IN PRACTICAL WILDLIFE MANAGEMENT

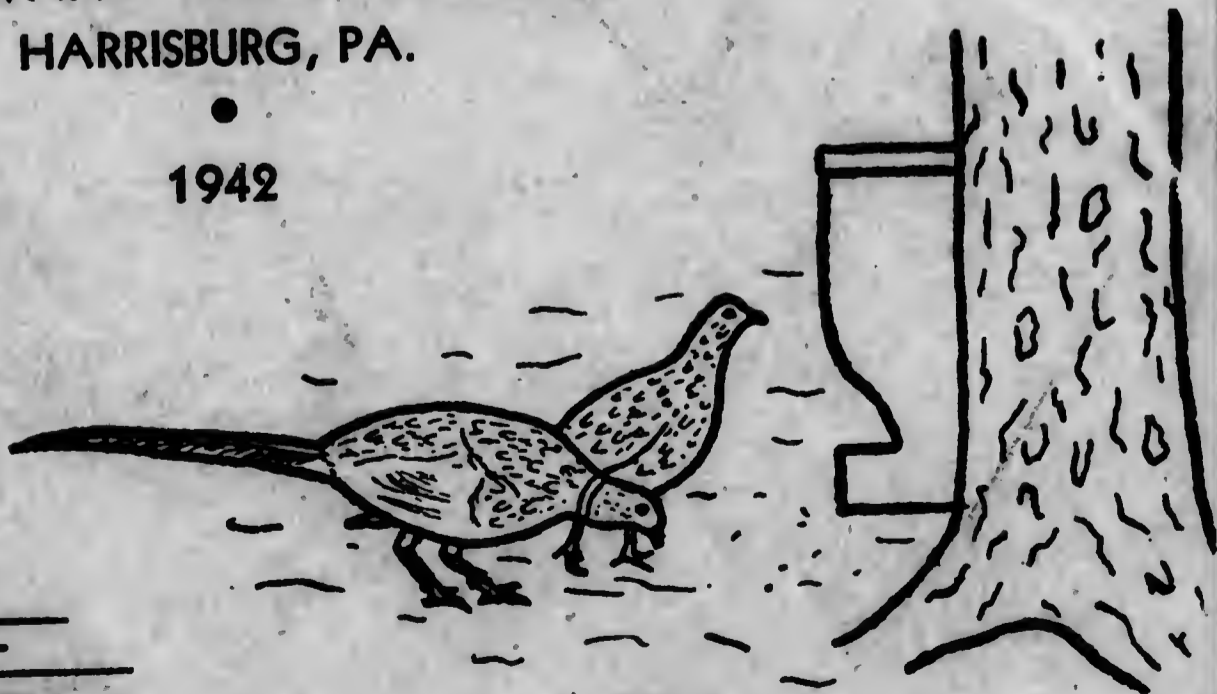
Research Bulletin No. 3

By **RICHARD GERSTELL**
Chief, Division of Propagation and Research

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THE PLACE OF
WINTER FEEDING
IN PRACTICAL
WILDLIFE MANAGEMENT

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PENNSYLVANIA GAME COMMISSION
COMMONWEALTH OF PENNSYLVANIA



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THE PLACE OF WINTER FEEDING IN PRACTICAL WILDLIFE MANAGEMENT*

INTRODUCTION

Winter feeding, as related to wildlife management, may be defined as the act of providing wild birds and mammals with supplemental food supplies during the winter months. At present this activity represents one of the principal components of game conservation as practically applied throughout large sections of the Northern United States and Southern Canada.

Regardless of its great popularity and unusual extent, superficial investigations of the practice seemed to indicate that the need for winter feeding is both greatly over-estimated and over-emphasized. Furthermore, when compared to the time, effort and money expended for it, the results obtained from the work appear disproportionately small. Thus, the purpose of this paper is to show, by detailed analysis of current practices, by a study of past records, and by the results obtained from a series of physiological experiments, the proper place of winter feeding in practical wildlife management.

* This study made possible through the financial assistance afforded by fellowships from Dartmouth College and the University of Michigan, together with the cooperation of the Pennsylvania Game Commission. The material herein presented was submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy in the University of Michigan.

PART I—THE WINTER FEEDING PROGRAM

A. History of the Practice

It is reasonable to suppose that a more or less instinctive urge "to throw a crumb to the cold, starving birds and beasts" has existed in a large percentage of the individual members of the human race ever since the earliest days of civilization. This may possibly explain why winter feeding programs have come into being and why they are so unusually popular.

A general review of the history of game management (Leopold, 1933) reveals the fact that the first record of an organized winter game feeding program is found in Marco Polo's report on the hunting preserves maintained in Cathay over six centuries ago by Kublai, "The Great Kahn." Just when the practice was inaugurated in Europe is a fact unknown, but indications are that it has existed there in different forms for several centuries.

The history of winter feeding in America is difficult to trace. Apparently, there were very few, if any, organized campaigns prior to 1900. Ten years later, however, the practice had become thoroughly established. To gain some conception of its development and current extent, it is probably best to study in some detail the reports from one particular state. For this purpose, the records of the Pennsylvania Game Commission are utilized both because a large-scale feeding program has long been maintained within that Commonwealth and because accurate data concerning it are readily available.

The annual, and later biennial, reports of the Pennsylvania Game Commission extend back over a period of more than forty years. Study of them reveals the fact that winter feeding was first mentioned in 1905 (Kalbfus, 1906). Incorporated in the report for that year is a copy of a letter forwarded to all interested persons by the Secretary of the Commission under date of January 3, 1905, bearing the title "Save Our Birds." In part, this communication states, ". . . hang up bundles of unthreshed grain, wheat, rye, buckwheat, millet, or anything that will supply the need, or better still, build covers under which they (bobwhite quail) can feed, choosing warm, protected corners along fence rows for this purpose." This statement is followed by directions for building a quail feeding shelter, after which comes the sentence, "Two or three covers of this kind will serve a good purpose on any farm, and be followed by a full return of money and labor expended, through the work (consumption of insects and weed seeds) of the birds." Another section of the letter reads, "Sportsmen and others interested in the preservation of the wild turkey should see to it that food of sufficient quality and in sufficient quantity be procured and placed during the winter months where it can be readily secured by these birds." Certainly these citations

definitely establish the fact that the Pennsylvania Game Commission over thirty-five years ago had encouraged the conduction of winter feeding programs throughout the Commonwealth.

Though the report for 1906 does not mention the subject, the Annual Report for 1907 (Kalbfus, 1908) presents a particularly significant statement. This is, "While the turkey and the grouse may be able to battle successfully with the snows and storms and to subsist fairly well from food gathering in the tree tops, the quail is not able to do this and is doomed to collect his food upon the ground or to die. A battle for a month or six weeks in the snow cannot fail to reduce the weight of this little bird fully one-third. Follow this with a day or so of cold rain, follow this again with a freeze, and one sees the end of Bobwhite. Wet and bedraggled with no food in his stomach, he is quickly chilled to the bone and the end of his journey reached." Immediately following is a second plea for the winter feeding of quail. The remark quoted doubtless typifies the beliefs at that time current, as well as the arguments generally used to promote winter feeding activities. In the light of experiments later described, it becomes of especial interest.

The "Save Our Birds" letter previously quoted from is again referred to in the 1908 report, while that for 1910 (Kalbfus, 1911) discusses the winter feeding of quail at some length. The point stressed is the fact that the farmers, who derive the greatest benefits from the birds through their destruction of weed seeds and insects, did little or nothing to help them through the winter, while interested sportsmen spent appreciable amounts of time, money and effort in winter feeding for the express purpose of providing at least a limited number of birds for sporting purposes. To quote, in part, ". . . It is otherwise with the sportsmen, for many years past I have known men of this class, in many sections of the State, spending both their time and money in caring for quail and turkeys and other wild birds. I know of one gentleman in Lewistown, who hired a horse and carriage, at least once a week, for more than two months, who bought buckwheat and screenings and other food and who traveled over a route of more than twelve miles, upon each trip, looking after and protecting nine covies of quail. . . . I know of numbers of gentlemen who cared for one or more covies of quail in this way, simply, that when the proper time came, they might enjoy a day's outing with gun and dog." These remarks clearly show the general extent and purpose of the winter feeding program of thirty years ago.

That decade extending from 1911 through 1920 witnessed great increase in the emphasis on winter feeding. The report for 1913 (Kalbfus, 1914) carries the following: "We are now making a study of how best to maintain, and, if possible, increase our game, and believe that through additional protection, which includes the feeding of our wildlife during

the wintertime, we can better attain the desired end than in any other way." In November of that year the Secretary of the Commission addressed to all sportsmen's organizations a letter urging the adoption of widespread winter feeding programs by those groups.

In 1914 (Kalbfus, 1915) the Commission requested passage by the State Legislature of a bill granting the body a minimum of \$25,000.00 for winter feeding, with the understanding that any surplus remaining from the feeding program would be used for the purchase of game for restocking purposes. Though the bill failed of enactment, the emphasis being placed upon the activities in question can readily be visualized when it is pointed out that the total Commission budget for the year 1914 amounted to only approximately \$50,000.00.

By 1916 the practice of winter feeding had become of so much importance that accurate cost records covering feed of this type were included in the annual statement showing the disbursement of funds by the Commission. The report for that year (Kalbfus, 1917) shows a total of \$506.88 spent for such material. During the years immediately following the expenditures were greatly increased. For example, by 1920 (Gordon, 1921) the figure had risen to \$9,687.43.

The 1917 report (Kalbfus, 1918) is of particular interest because in it is found the first mention of special plantings to provide winter food for wildlife. All previous activities apparently dealt entirely with emergency feeding, that is, the distribution of supplemental foods during periods of stress. Two short sections from the report are quoted herewith:

Food Questions

"The question of an adequate food supply for game of all kinds during the time when our State is covered with ice and snow, is the paramount question for consideration, and that without this food supply more game by far will be lost each year than is destroyed either by forest fires or is taken by hunters legally or illegally, and to that end we are doing all in our power to feed and strengthen our game, especially our wild game birds such as turkeys, quail, ruffed grouse and ring-necked pheasants."

Planting of Food-Producing Trees and Vines

"We recommend, therefore, in this connection that the sportsmen of this State, either individually or as organizations, get in touch with the representative or owner of forest lands in the neighborhoods of where they may reside or hunt, also get in touch with State Foresters, where such lands are in question, and see to it that trees and vines and shrubs that will supply our beneficial wild-life with food, such as apple trees, mountain ash, sassafras, dogwood, haws, both red and black, the chinquapin, with other nut-bearing trees and vines of various descriptions, be planted wherever they can be made to grow, for now that the chestnut blight is sweeping away the chestnut trees, the food supply of our wild-life must be short indeed, unless something is done to take its place."

The feeding program continued to grow during the 1920's. There were greatly enlarged expenditures for emergency feeding; the planting of food-producing trees and shrubs was conducted on a much broader scale; while cooperation by all interested persons was constantly stressed through the better known methods of disseminating the written and the spoken word.

The biennial Report for 1922-24 (Gordon, 1924) in several places makes reference to the winter feeding activities. Though a two-year general program announced at that time listed as one of its nine major points more extensive winter feeding of game and wild birds, the principle emphasis during the period was upon the planting of permanent food and cover. For example, there is the statement, "An effort has been made to encourage the people of Pennsylvania to plant more permanent food and cover for wild life. Interested sportsmen and representatives of the Board (of Game Commissioners) have already accomplished much along this line, and the work is only fairly started. With the continued assistance of those interested, it will be possible to conduct such planting operations on a much more extensive scale in future years. Food and cover are absolutely necessary to increase game, and no better line of activity can be undertaken by individuals and conservation organizations." The planting record established by the Commission during the biennium, which was in addition to the work carried out by private persons working individually and in groups, is as follows: Game food-producing seedlings, 96,446; grapevine and similar cuttings, 16,070; berry bushes, 12,150; and 948 quarts of wild nuts of various kinds.

The report for the 1925-26 biennium (Truman, 1926) mentions the establishment of a special game-food nursery at Refuge No. 3, South Mountain. In 1925 the first extensive plantings for wild waterfowl were made at forty-nine locations in twenty-eight counties, while the Commission's first publication devoted exclusively to winter feeding was released in the same year (Gordon, 1925). Perhaps the most impressive portions of the report are summarized in the following excerpts from the section entitled "Game Feeding": "... Game feeding work has been stressed continuously during the past two years, and sportsmen, landowners, Boy Scouts, rural mail carriers and others gave our officers splendid assistance. . . . The farmers in many sections of the State did considerably more feeding than the sportsmen, most of it at their own expense. . . . The most spectacular . . . was the distribution of grain from an airplane. . . . In addition to grain distributed in the sheaf, in the shock, and otherwise, a special effort has been made to furnish more feed by planting grains of various kinds. . . . This makes a total of 734½ acres of feed planted for which the Board of Game Commissioners paid \$8,277.61 during the biennium. . . ."

The record for the years 1927 and 1928 (Truman, 1929) reveals the fact that the money expended for the purchase of grain for winter feeding amounted to \$4,087.17 in 1926-27 and to \$15,021.04 the following winter. Also, in 1928 the first edition, numbering 10,000 copies, of the Commission's bulletin "More Food for Upland Game" (Conklin and Morton, 1928) was printed and made available to the public. This well-written and clearly illustrated pamphlet is primarily concerned with outlining proper methods to be followed in winter feeding, especially by means of feeding stations.



Figure 1. A brush shelter filled with cull apples.

The report for the 1929-30 period (Slautterback, 1930) contains little significant information other than the figures on monies expended for grain for winter feeding which totaled \$16,326.64 in 1928-29 and \$24,436.45 in 1929-30.

The decade last past, extending from 1931 through 1940, witnessed the continued growth of the winter feeding activities already described. This was naturally accompanied by certain changes and innovations.

The Commission's first experiments with imported chestnuts were reported as undertaken in 1931 (Harwood, 1932) when 1,450 Asiatic chestnut seedlings were planted to test the feasibility of attempting thus to replace the native species lost through the blight.

With the inauguration of the various work-relief programs in 1933, when the CCC and the PWA were first in operation, the Commission entered upon a greatly enlarged plan for food and cover development, particularly on State Game Lands and Refuges. As outlined in the Biennial Report of the Board of Game Commissioners for 1935-36 (Anonymous, 1936a), among the principal activities to be included in the work were the following: (1) The making of release cuttings, especially in the vicinity of wild grapevines, bittersweet vines, thorn apples, hawthorns, elderberries, blackberries, sumac and other small-sized game food producing plants; (2) the cutting of trees in strips or plots to stimulate sprout growth which in turn supplies browse for deer, as well as stimulates the production of berry and nut-producing shrubs; (3) transplanting nut- and berry-producing trees, shrubs and vines from thickets to spots where they can be expected to grow; (4) seeding tillable areas with grains and legumes, especially in the southern part of the State, to furnish food for wild turkeys, ruffed grouse and other small species desiring such food; and (5) constructing feeding shelters for winter use.

During the severe winter of 1935-36, a record expenditure for the purchase of feed for wild game was made. This totaled \$27,671.06 in amount.

The Commission report for 1937-38 (Anonymous, 1938a) reveals the fact that during the biennium over 221,600 game food-producing trees, shrubs and vines were raised at the State Forest Nursery at Mont Alto and at the Commission nursery at Beavertown, established in 1934. Among the species included were bittersweet, Asiatic chestnut, Russian mulberry, Japanese rose, perisimmon and frost grape.

In 1939 (Anonymous, 1941) the first report of the distribution of apple pomace (residue from cider presses) for winter food for wildlife is found. Over 300 tons of this material were distributed throughout the State, while orchardists donated more than 1,200 bushels of cull apples for similar use. Furthermore, continuing a practice inaugurated a few years before, over 76,000 wild apple trees were pruned to assure a maximum crop of fruit for game food. The cut twigs and branches were placed in piles for use by deer and rabbits.

During the 1939-40 biennium over 16 tons of the Pennsylvania Game Food Plot Mixture Seed were planted throughout the State, principally by interested farmers and sportsmen (Anonymous, *ibid.*). The sowing of this special seed mixture, developed in 1937 and first made publically available in 1938 (Morton, 1937), resulted in countless dozens of patches, totaling hundreds of acres in extent, of standing winter food.

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At the same time, with the help of the various federal relief agencies, representatives of the Commission planted over 1,600,000 game food-producing trees, shrubs and vines to provide permanent sources of

nourishment. Furthermore, 1,286 game food plots were established on State Game Lands. Over 1,000 acres of land under Commission control were planted to small grains by neighboring farmers on a share basis. In addition to that portion left standing under the agreements, the Commission received approximately 8,000 bushels of grain which was used for winter feeding. A like amount was raised by Commission employees at the Pymatuning Wild Waterfowl Refuge for the same purpose.

The report for the biennium last mentioned (Anonymous, *ibid.*) also states that during the two years, a WPA art project, inaugurated in 1938, manufactured for state-wide distribution over 15,000 colored posters promoting winter feeding. These were placed in store windows, in schools and other public buildings and were posted at hunting camps and along highways for the purpose of creating greater interest in winter feeding.

From these facts it is obvious that there has been during the past thirty-five years a constant increase in the general extent of, as well as the number of persons cooperating in, Pennsylvania's winter wildlife feeding program. The information presented in the preceding paragraphs clearly outlines the growth of the Commission's activities, but the reader must not overlook the very important fact that these doubtless represent only a comparatively small fraction of the total feeding work carried on throughout the Commonwealth.

Though in some instances less money may have been available for the work, the general history of winter feeding in New York, Michigan, Wisconsin and other states and provinces has closely paralleled that of Pennsylvania.

B. Methods Employed

As commonly practiced, winter feeding activities are of two principal types, continuous and emergency. Occasionally some programs embrace the characteristics of both systems.

Broadly speaking, continuous feeding involves the provision of constant supplies of artificial feed throughout the winter months, regardless of varied weather conditions. As originally practiced, this usually involved the construction of feeding stations of various types wherein the food was placed at more or less regular intervals.

Feeding shelters and dispensers are of many different kinds, ranging from natural spots of protection, such as hollow logs and over-hanging rocks, to complicated permanent structures with automatic supply bins which need be filled only at long intervals. Some of the more common types are briefly described below.

Brush shelters are readily formed by piling corn stalks, straw or ever-green boughs on branch frames. These provide a snow-proof roof under which the feed may be scattered. Box feeders are those similar to the hoppers frequently used for domestic stock. They may be fabricated with

either wood or metal. Basket feeders are easily constructed of new or used poultry netting. The wire is merely bent into a log-shaped basket which is fastened to a tree and kept filled with ear corn or similar material. Stovepipe feeders may be constructed of new or old tin pipe which is converted into a simple hopper with a minimum of work. Various types of barrel feeders are often used. In the main, they consist of a large wooden or metal barrel used as a storage center. This is fitted with an



Figure 2. Hanging a box type feeder.

outlet pipe, or chute, which serves to keep a constant supply of food on the feeding tray. A less complicated device is the spike pole feeder constructed by means of driving long spikes through a small pole so that the pointed ends protrude an inch or more. Nailed between two trees, ear corn is placed on the nail points.

Certain of the feeders just described are illustrated herein, while full construction details covering them, as well as many additional types, are given elsewhere. (Conklin and Morton, 1939.)

In 1917, as previously mentioned, came the initial significant change in the system of continuous feeding. During that year, the first plantings of winter food plots were made. These consisted of small areas sown to various grains which were to be left unharvested to provide a more

nourishment. Furthermore, 1,286 game food plots were established on State Game Lands. Over 1,000 acres of land under Commission control were planted to small grains by neighboring farmers on a share basis. In addition to that portion left standing under the agreements, the Commission received approximately 8,000 bushels of grain which was used for winter feeding. A like amount was raised by Commission employees at the Pymatuning Wild Waterfowl Refuge for the same purpose.

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Certain of the feeders just described are illustrated herein, while full construction details covering them, as well as many additional types, are given elsewhere. (Conklin and Morton, 1939.)

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natural supply of supplemental winter food for game. In the late 1920's, the practice of leaving unharvested strips of regular farm crops began to be more widely followed. The latest change has been the development in Michigan (Wight, 1931), Pennsylvania (Morton, 1937) and other states of special food plot mixtures. These are comprised of the seeds of various

TABLE I
PENNSYLVANIA GAME COMMISSION'S ANNUAL
EXPENDITURES FOR WINTER FEED FOR WILD GAME
1915-1940

(Figures given represent actual cost of feed. No distribution charges are included.)

Winter of	Amount Expended	Winter of	Amount Expended
1915-16	\$506.88	1927-28	\$15,021.04
1916-17	2,087.07	1928-29	16,326.64
1917-18	3,885.25	1929-30	24,436.45
1918-19	3,658.42	1930-31	10,878.65
1919-20	9,687.43	1931-32	11,752.71
1920-21	5,144.59	1932-33	11,620.80
1921-22	1,736.78	1933-34	11,935.01
1922-23	2,198.25	1934-35	9,516.52
1923-24	3,928.75	1935-36	27,671.06
1924-25	9,830.30	1936-37	13,144.01
1925-26	15,449.75	1937-38	7,366.64
1926-27	4,807.17	1938-39	7,575.85
1939-40	\$10,282.80		

Grand Total\$240,448.82

Annual Average 9,617.95

(Source of data: Annual and Biennial Reports of Pennsylvania Game Commission, Harrisburg, Pa., 1915-1940.)

species of game food-producing plants which provide sustenance at different seasons of the year. Thus, planted in the spring, they mature by late summer and constantly supply both food and cover throughout the critical periods of fall and winter.

The object of the changes just discussed is, of course, to furnish supplemental winter feeds in a more natural manner than afforded by shelters and feeders.

★ Emergency feeding involves the distribution of supplemental winter foods during periods of severe weather, particularly following deep snows, after ice storms and when environmental temperatures are unusually low. Under this system, food is scattered in those places where game is believed most likely to find and to use it, or placed in feeding shelters at

other times unused. The activities are discontinued just as soon as the period of severity ends. It is in this work that airplanes are occasionally employed to drop food in the more inaccessible regions.

C. Extent of the Activities

To determine the exact extent of the winter feeding activities annually carried on throughout the Northern United States and Southern Canada is, of course, impossible. Some concept of it may, however, be gained by once again resorting to the records of the Keystone State.

First of all, there are the statistics covering the expenditure of funds by the Pennsylvania Game Commission for the purchase of feed, principally small grains, for winter distribution. These are summarized in Table 1, page 10. Ranging from a low of \$506.88 in 1915-16 to a high of \$27,671.06 during the unusually severe winter of 1935-36, the total expended during the past twenty-five years has exceeded \$240,000.00, representing an annual average of a little more than \$9,600.00. As indicated, this represents merely the cost of the food. It does not include the expenses incurred in its distribution. Furthermore, as shown by the outline X of the history of the program, the emphasis in recent years has been placed not on the emergency distribution of purchased grain mixtures but on the planting of special food plots the cost of which are not reflected in the data presented in the table. Thus, the total direct expenditures of the Commission far exceed those shown for the game food purchases.

Secondly, as previously stated, the activities of the Commission represent only a comparatively small portion of the total feeding program conducted within the Commonwealth. Some concept of the extent of the interest in the work may be had by considering the demand for the feeding bulletin mentioned heretofore. First printed in 1928, Commission Bulletin No. 11, "More Food for Upland Game," has gone through seven editions totaling 90,000 copies. Practically all of these have been mailed free of charge to interested Pennsylvanians. ★ Each year more and more newspaper space, as well as radio time, has been devoted to attempts at increasing the extent of public participation in the feeding programs, while illustrated lectures and other techniques have been used among sportsmen's groups, farm clubs and school children to stress cooperation in the work.

X Though it is impossible accurately to determine the figure, it is obvious that countless thousands of Pennsylvania residents annually make a practice of carrying out some greater or lesser winter feeding work. Many of these persons are farmers interested in having quail and similar birds about their properties. Others are individual hunters who take a keen interest in observing the habits of game birds and mammals. A large

portion are members of sportsmen's clubs with special feeding programs designed to provide better shooting for all, while appreciable numbers are interested solely in the increase of song and insectivorous birds. The total value of the time and effort expended by these people in constructing shelters and distributing the food, together with the cost of the materials fed, undoubtedly amounts to many tens of thousands of dollars each year.



Figure 3. Ice storms in combination with heavy snows reduce the availability of wildlife foods to a minimum.

It is true that Pennsylvania was one of the first states to develop a large-scale game conservation program, but, particularly as related to winter feeding, a number of others followed close behind. A survey conducted in 1927 (LéCompte, 1927) reveals the fact that even at that time organized quail feeding programs were conducted by the conservation departments and private individuals of at least 12 northern states and one province. Included were Connecticut, Idaho, Indiana, Iowa, Maryland, Michigan, Minnesota, New Jersey, New York, Pennsylvania, Washington, West Virginia and Ontario. Doubtless private individuals carried on campaigns to feed the quail in many other states.

It is significant to note that almost all reports from practically every state and province stress the extensive work of those private individuals who assist in the feeding activities. Included are farmers, representatives

of sportsmen's organizations, members of bird clubs, Boy and Girl Scouts, school teachers and children, rural mail carriers and countless others.

To aid these people, there are many publications dealing with winter feeding. Among them is one of the United States Department of Agriculture's Farmers' Bulletins (Grange, 1937). Another is a pamphlet distributed by the Izaak Walton League of America (Anonymous, 1931), while a third (Anonymous, 1938b) was prepared and released by a commercial firm engaged in the manufacture of ammunition for sporting arms. Like Pennsylvania, a number of other states have also published guides and leaflets on the subject. Among them are Michigan (Pirnie, 1930), Missouri (Godsey, 1931; and Nagel and Bennitt, 1937), North Dakota (Fox, 1941), Ohio (Hicks, 1931) and West Virginia (Anonymous, 1936). Printed reports of somewhat different types have been prepared by workers in many additional states, including Connecticut (Dalke, 1935), Iowa (Errington, 1930), Minnesota (Miller, 1938), New York (Bump and Bradley, 1940), and Wisconsin (Hawkins, 1937). Considered as a whole, these publications are found to be not only numerous but also widely distributed.

Based on the reports studied, it would certainly appear that there are in the Northern United States and Southern Canada some hundreds of thousands of persons who annually participate to a greater or lesser degree in the winter feeding programs within the various states and provinces, spending thousands upon thousands of dollars in connection with their activities of this type.

Because of the vast amounts of time, effort and money spent by such a large number of persons solely for the winter feeding of wildlife, the desirability of securing an accurate appraisal of the results obtained from the work is obvious.

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PART II—THE ACTUAL NEED FOR WINTER FEEDING

A. Past Records

As indicated by the history of the practice, many persons firmly believe that throughout the Northern United States and Southern Canada winter feeding is absolutely necessary to the annual production of game crops, particularly in the form of non-migratory birds, which may be harvested through shooting. The basis upon which this belief has been built is unknown, though the factor which has allowed for its widespread development is doubtless that previously discussed, inborn "urge to throw a crumb to the cold, starving birds and beasts."

It would be logical to suppose that the origin of the general belief in the necessity for winter feeding might lie in past observations and reports of extensive winter starvation among wild birds and mammals. To check the validity of this supposition, a fairly comprehensive survey of the available literature has been made. Since the majority of the various winter feeding programs have been aimed at the care of birds of numerous species, the ornithological publications were given more attention than those pertaining to mammals.

The bulk of the pertinent writings is comparatively recent, extending back over a period of less than seventy-five years. Unfortunately, except for certain of the studies conducted during the past ten or twelve years, even these references are more of an historical rather than a scientific nature. Thus, though often providing definite records of the destruction of large numbers of animals during the winter months, they frequently offer no clues as to the causes thereof.

Possibly the earliest record worthy of consideration is the "cold Friday" in the winter of 1874-75 in northeastern Missouri which is reported (Leopold, 1931) to have resulted in the destruction of many bobwhite quail. The same author refers to a "big snow" in 1881-82 which killed quail in Wisconsin and Michigan.

A cold wave in the South in the late winter of 1894-95 caused the destruction of large numbers of birds of various species, particularly bluebirds. In this connection, it has been written (Forbush, 1912) that, "In 1895 nearly all the bluebirds of New England were destroyed by a great storm and cold wave in the South; but as they were protected by law at all times they became almost as plentiful as ever a few years later, while the woodcock, which was less affected by the freeze, but is shot in all states, hardly has begun to approach its former numbers."

On February 13th and 14th, 1899, a severe storm struck the coast of South Carolina. The minimum temperature at Mount Pleasant (Wayne, 1899) was 14°F. on the 13th and 6°F. on the 14th. "Fox sparrows and snowbirds were killed by the millions." Among the other species found

dead in large numbers were finches, mourning doves and woodcocks. Of the latter, "countless thousands were frozen to death," while thousands more in a weakened condition were killed by men and boys with sticks. A second report on the same storm (Rice, 1924) at Wiggins, South Carolina, states that doves, mockingbirds, bluebirds, cardinals and sparrows were found dead in large numbers, but that "turkeys, partridges and ducks apparently suffered not at all." Here wheelbarrow loads of woodcocks are said to have been killed with sticks. It is significant to know that in one case these losses were attributed to "freezing" and in the other to "starving," though neither writer gives the basis for his statements.



Figure 4. Bobwhite quail dug from imprisonment in a snow drift.

There is a rather detailed report (Roberts, 1907a) of tremendous losses of Lapland longspurs in Southwestern Minnesota and Northwestern Iowa in March, 1904. By sample counts, the estimated number of the birds lying dead on the surface of two small lakes was placed at 750,000. The total loss was believed to be several millions. In this case, the birds were caught in a snow storm while migrating northward. Autopsies performed on a number of specimens revealed the fact that practically all birds picked up in the towns of Washington and Slayton, Minnesota, possessed obvious signs of various mechanical injuries to which their death was

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A second, lesser destruction of bluebirds occurred during the winter of 1911-12 (Cooke, 1913). As was the case in 1894-95, these losses were attributed to the "freezing" of birds which had started their northward migration.

In Europe the winter of 1916-17 was unusually severe. A compilation (Witherby and Jourdain, 1917) of the recorded losses in different parts of the British Isles showed that large numbers of many different species of game and non-game birds were destroyed. A few of those listed include partridges, widgeons, grebes, curlews, tits, wrens and starlings. The writers specifically mention devastating ice storms as contributory to a general food shortage which they believed responsible for the losses.

The winter of 1917-18 was particularly severe throughout the Northern United States and Canada. Extremely low temperatures were common, while heavy snows covered the ground for unusually long periods of time. Quail are known to have suffered serious losses in the North Central (Leopold, 1931) and other states, including Pennsylvania (Kalbfus, 1919). In the Keystone State it was reported, "... notwithstanding our effort to locate and feed quail throughout the last winter, thousands of these birds were either starved or frozen. ..." The estimated hunters' take within the Commonwealth in 1918 was only about 44% of that for 1917, with approximately the same number of gunners in the field each season. Similarly, it has been noted (Wilson, 1922) that in Kentucky there was a reduction in the numbers of song birds, including mocking-birds, wrens and tree sparrows, following the same winter.

Extremely cold weather toward the end of February, 1929, resulted in a second great destruction of all kinds of birds in England (Witherby and Jourdain, 1929).

The effects of severe winter weather on a small population of mourning doves in Iowa in 1934-35 have been reported (Errington, 1935).

The unusually cold winter of 1935-36 resulted in the death of relatively large numbers of birds of different species. Except for mention of the destruction of a small number of flickers (Errington, 1936), however, these losses are treated under the specific groupings later presented.

In England the winter of 1939-40 was the coldest so far occurring in the twentieth century. The temperature at some points dropped as low

as 10° below zero (F.), while there were unusually heavy ice storms, as well as extended periods of dull, cloudy days (Hawke, 1940). Large numbers of birds perished in many sections of the British Isles. Among the species found dead were robins, greenfinches, chaffinches, skylarks, goldcrests, starlings, song-thrushes, blackbirds, herons, snipe, moorhens, salops, red grouse, partridges, white-fronted geese, sheld ducks, oyster catchers, redshanks, curlews, common scoters, tufted ducks, herring and common gulls, razorbills, guillemots and puffins. The majority of the losses were attributed to the cold rather than to starvation inasmuch as



Figure 5. Setting out aquatic plants for waterfowl.

many of the specimens examined were found to be in good flesh. Some individuals, including wood pigeons, finches, buzzards and moorhens, died as a result of freezing fast during the storms (Ticehurst and Witherby, 1940). All in all, the losses were quite severe with breeding season counts showing a decrease of approximately 25% in the heron population, attributed to winter-killing (Alexander, 1941).

Early 1940 was also unusually severe in the United States. This was particularly true for the South where many species of birds suffered heavy losses. Tree swallows were found to have died in large numbers in Florida in January. In this connection, it was stated that "the fundamental cause of death was cold" (Christy, 1940). Another report from

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the same state includes tree swallows, chuck-will's-widows and whip-poor-wills among the forms which perished, but the writer attributed the deaths to starvation (Weber, 1940). A third Florida observation concerned mortality among myrtle warblers (Ruff, 1940). In Louisiana, the "weakening" of woodcocks and the "starvation" of killdeer, kinglets, phoebes and myrtle warblers was noted (McIlhenny, 1940). The loss of quail in Wisconsin was put at 25% of the total population, while the death from exposure of two chuckar and three Hungarian partridges "with full crops" was also recorded (Scott, 1940).

A severe blizzard which swept the Upper Mississippi River Valley on Armistice Day of 1940 caused the death of red-winged blackbirds, meadowlarks, slate-colored juncos, tree swallows and other species, even including domestic pigeons (Scott and Baskett, 1941). The destruction of large numbers of birds by wind, snow and cold during a period of only several days in early fall is indeed unusual.

Beginning about 1930, the mechanics of winter losses were given special attention. Since that time, quite a number of studies along such lines have been conducted by capable research workers. These have dealt primarily with game species, though other birds have not been ignored. Principal among them have been those pertaining to bobwhite quail.

In a number of instances, the investigations have shown that lack of food was probably the primary factor involved in heavy winter losses among quail (Errington, 1931; Leopold, 1933; and Trautman, Bills and Wickliff, 1939). On the other hand, there are on record definite cases where cold was apparently the principal agent in the seasonal destruction of bobwhites (Errington, 1933; Leopold, 1937; and Wade, 1938). In this connection, the writer's experiments (Gerstell, 1939a), which showed that the ability of well-fed quail to withstand low environmental temperatures is dependent upon the number of individuals in a covey, are of interest. Many times it has been found that winter quail losses resulted from a combination of cold and hunger (Errington and Hammerstrom, 1936; Kendeigh, 1933; and Leopold, 1933). In several instances, the author has helped to dig out covies of quail which had been imprisoned by drifted snow. Some of these groups had perished, apparently as a result of the absence of food, but possibly because of the lack of air. Others were rescued alive after several days of such confinement. There are similar reports from other states, including Iowa (Scott, 1937).

Among ringneck pheasants, appreciable winter losses have been reported only from the Prairie States. In Iowa, during the severe winter of 1935-36, there was recorded (Green and Beed, 1936) the death of 250 pheasants out of a population of approximately 400 birds. Of those lost, 131 froze to death or died from accumulations of ice about the oral and

nasal openings; 37 were imprisoned in the snow; 13 perished with pneumonia; one died of starvation; while the remainder succumbed to other than meteorological factors. Of 106 dead pheasants found in Minnesota during the same winter, it was reported (Fried, 1940) that 33 contained no food in the intestinal tract, while 12 of the group were extremely emaciated. In the latter 45 cases only was death attributed to starvation. Also in 1935-36, heavy pheasant losses from starvation in New York State were rumored, but representatives of the Department of Conservation could find only 170 dead birds of which the deaths of but 39 were attributed to starvation (Anonymous, 1937a). In South Dakota during the winter of 1936-37, unusually heavy pheasant losses were reported (Beed, 1938). Here starvation was apparently an important factor. For example, of 126 birds collected after death, the stomachs of 104 "contained no food whatsoever." The ill-famed 1940 Armistice Day storm resulted in the loss of large numbers of pheasants in North-Central Iowa. In one area these totaled over 10% of the resident population. The deaths were attributed to unusually high winds accompanied by falling snow and rapidly dropping environmental temperatures, rather than to food shortages (Scott and Baskett, 1941). The same storm in combination with a blizzard in March, 1941, is reported to have reduced Minnesota ringneck densities from 50 to 29 birds per square mile (Carlson, 1941).

Serious winter losses among ruffed grouse are conspicuous by their absence. A report from the State of New York (Anonymous, *ibid.*), where the grouse has been the subject of thorough investigation, states, in regard to the winter of 1935-36, "It is particularly significant to note . . . that not a single grouse was received in starving condition . . ." In January, February and March of 1936, the writer found over 20 dead grouse all of which had apparently been imprisoned by strong crusts formed after the birds had sought night shelter in fresh snow. Only one bird was found at a place, though four were uncovered by a snow plow in a stretch hardly more than three miles in length. All had been too long dead to render detailed laboratory autopsies worthwhile, but cursory field examination seemed to indicate that death finally had resulted from inability to obtain food due to their confinement. Similar findings have been reported from other states (Leopold, 1933; King, 1937; and Dery, 1941). Except for losses such as these, however, the grouse doubtless suffers few, if any, winter hardships. Its habit of "budding," the feathering of its feet and other peculiarities, both anatomical and physiological, render the bird particularly well adapted to combat meteorological extremes.

During February and March of 1936, small numbers of wild turkeys were found dead at various points in South-Central Pennsylvania. The writer picked up two such specimens and secured three additional birds

located by other persons. Laboratory examination revealed the fact that all were in good flesh and that the crops of each were filled with a combination of green foods and corn. Obviously, these losses were not the result of starvation. Particularly in view of the fact that two individuals were found covered with ice immediately following a severe ice storm, while the remainder perished during periods of unusually low temperature and high winds, it appears that the deaths were caused by exposure.

Among the wild waterfowl, there are a number of records of winter losses. Of these reports, one of the most complete deals with conditions in Northwestern Ohio in March, 1932 (Trautman, Bills and Wickliff, 1939.) Over 300 dead ducks, including blacks, ringnecks, canvasbacks, mallards, gadwalls, baldpates, redheads, pintails and lesser scaups, and approximately the same number of coots were found, while the total estimated loss during the period was considered to be "at least a thousand." As revealed by the report, a large percentage of these losses were in the main the result of inadequate food supplies.

On Lake Michigan in February of 1936, hundreds and possibly thousands of ducks are reported to have perished when extreme cold caused such extensive freezing over the lake waters that the food supply of the flocks was cut off. Among the species found dead were greater scaups, goldeneyes, American mergansers, old squaws and a king eider (Gromme, 1936). Also during the severe cold of early 1936, American goldeneyes, greater scaups and a white-winged scoter were frozen to the beaches of Long Island Sound. Some individuals tore away their skin in their struggle to escape (Cruickshank, 1936).

In 1936 and again in 1937, the starvation of large numbers of ducks was reported from the Snake River Valley of Idaho. Among the species submitted to laboratory examination were mallards, widgeons, pintails, lesser scaups, green-winged teal, American goldeneyes and gadwalls. In all, over 100 individuals from this region were studied, together with 19 additional specimens from the Bear River Marshes in Utah. It was concluded that the percentage of the total wintering population lost was less than one percentum and that the great majority of the deaths were due to causes other than starvation (Kalmbach and Coburn, 1937).

During a period of extended cold in early 1940, the writer assisted in locating a number of dead and dying ducks on the Maiden Creek Dam near Reading, Pennsylvania. In this case, it was significant that all the afflicted birds, approximately 75 in number, were hybrid individuals resulting from the crossing of a number of wild blacks with semi-domestic mallards. Blacks, teal, pintails and semi-domestic mallards on the area at the same time were little effected. With the limited foods available, the hybrid birds apparently were unable to withstand the rather extended periods of low temperature.

A report typical of those currently being prepared by workers interested in wildlife losses is concerned with the destruction of starlings, grackles and cowbirds by a storm at Urbana, Illinois, on the night of February 9, 1939 (Odum and Pitelka, 1939). In this instance full details of the catastrophe are given. These relate to the intensity of the storm, the percentage of birds killed and other pertinent facts.

Numerous other records of bird destruction are to be found in the literature. The majority of them have, however, no direct bearing on



Figure 6. A group of deer which perished as a result of malnutrition.

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Though admittedly not searched as carefully as the ornithological literature, because the emphasis in winter feeding is related to birds rather than mammals, the mammalian records apparently contain far fewer reports of winter losses than do those pertaining to the avian species. This may possibly be due to the fact that the more commonly noted mammals are not subject to the same degree of destruction during severe weather as are the birds. It is also interesting to note that practically all the pertinent records relate to the larger species, particularly those classed as big game, such as the elk and the deer.

located by other persons. Laboratory examination revealed the fact that all were in good flesh and that the crops of each were filled with a combination of green foods and corn. Obviously, these losses were not the result of starvation. Particularly in view of the fact that two individuals were found covered with ice immediately following a severe ice storm, while the remainder perished during periods of unusually low temperature and high winds, it appears that the deaths were caused by exposure.

Among the wild waterfowl, there are a number of records of winter losses. Of these reports, one of the most complete deals with conditions in Northwestern Ohio in March, 1932 (Trautman, Bills and Wickliff, 1939.) Over 300 dead ducks, including blacks, ringnecks, canvasbacks, mallards, gadwalls, baldpates, redheads, pintails and lesser scaups, and approximately the same number of coots were found, while the total estimated loss during the period was considered to be "at least a thousand." As revealed by the report, a large percentage of these losses were in the main the result of inadequate food supplies.

On Lake Michigan in February of 1936, hundreds and possibly thousands of ducks are reported to have perished when extreme cold caused such extensive freezing over the lake waters that the food supply of the flocks was cut off. Among the species found dead were greater scaups, goldeneyes, American mergansers, old squaws and a king eider (Gromme, 1936). Also during the severe cold of early 1936, American goldeneyes, greater scaups and a white-winged scoter were frozen to the beaches of Long Island Sound. Some individuals tore away their skin in their struggle to escape (Cruikshank, 1936).

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Serious winter losses of moose on Isle Royale in Lake Superior were reported in 1934. A study of the problem (Hickie, 1936) showed that malnutrition, brought about by heavy overbrowsing, was the principal cause of the deaths.

In North America, the first recorded reports of serious winter elk losses were those suffered by the famous Northern Yellowstone Herd during the winter of 1911-12. These have ever since cropped out at intervals. They are largely the result of malnutrition brought on by the absence of winter food of good quality, but some few cases of actual starvation have been recorded (Rush, 1931).

Winter deer losses have at least in Europe been known for centuries. Possibly one of the earliest references on the subject is a recent quotation (Neuse, 1937) from the reminiscences of one Johann Philipp Munch, who wrote in the late 1600's of a trip he had taken through the forests near Corven, Germany. He stated, in part, ". . . die Kälte war so gross und dauerte so lange, dass ich auch das Wild in Haufen tot im Walde Liegen fand . . .".*

In the United States, the famed Kaibab and Pennsylvania "deer problems" reached serious proportions in the early 1920's. The former, possibly most acute from about 1924 through 1928, is now greatly alleviated, but the disastrous effects of overpopulation on both the deer and the range are still obvious (Bell, 1930; Goldman, 1932; and Boone, 1938). In the Keystone State, the situation became critical about 1928, while present conditions continue to reflect unfavorable trends (Bailey, 1930; Winecoff, 1930; Clepper, 1931; and Gerstell, 1935 and 1938a). More recently, similar developments have been reported from Michigan (Bartlett, 1938), while additional areas probably are approaching rapidly the same difficulties. All these "deer problems" are characterized by heavy winter losses annually involving thousands of individuals. The deaths of the animals are commonly attributed to starvation, but more correctly speaking they are the result of malnutrition as the deer in most instances die with full stomachs (Bailey, *ibid.* and Gerstell, *ibid.*). The material contained therein is invariably of comparatively low food value.

Records of serious winter losses among the better known and commonly noted small mammals, such as the squirrel and the rabbit, are practically non-existent. The writer observed the desiccated carcasses of several grey squirrels found in a hollow tree in the spring of 1936. The animals apparently died in "good flesh," thus it is entirely possible that they were the victims of the extended periods of unusually cold weather common

* Translation: ". . . the cold was so great and lasted so long, that I even found deer lying dead in piles in the forest. . . ."

to the winter of 1935-36. Woodcutters working in the same general area told of finding "several dozen" similar specimens, but the total loss appears to have been of no appreciable extent. Certainly it represented no commonly observed spectacle.

The destruction of small numbers of cottontail rabbits and one white-footed mouse by the 1940 Armistice Day storm has been reported from Iowa (Scott and Baskett, 1941). Particularly in view of the comparatively high cottontail population densities in the Corn Belt, the rabbit losses were doubtless of little or no significance.

Careful evaluation of the records just cited would appear definitely to establish the fact that the observation of widespread starvation during the winter months cannot represent the basis of the commonly held belief in the need for winter feeding. In the first place, except for the deer losses, which are in the main of recent origin, the bobwhite quail is the only species which the reports indicate is subject to relatively heavy winter losses throughout the Northern United States and Southern Canada, while even some of the earlier records (Kalbfus, 1919) clearly state that "freezing" and imprisonment in drifted snow are major factors in the winter killing of these birds. Secondly, a number of the major catastrophes, such as the bluebird and longspur disasters previously mentioned, have definitely been shown to be the result not of long spans of food scarcity, but of short periods of storm and cold occurring during the height of migration. Third, many of the heaviest winter losses, such as those recorded from South Carolina in 1899, as well as those occurring throughout the South during the unprecedented cold wave of February, 1940, are occasional happenings which take place only at long intervals in areas where ice and snow are the exception rather than the rule and where no winter feeding is ever attempted. Finally, in those cases where starvation is known to have exacted its toll, for example, among the Dakota pheasants and the ducks of Ohio, the total number of individuals involved was comparatively small when compared to the aggregate population totals for the species concerned. In addition, the dead and dying birds were probably not observed by large numbers of people.

Furthermore, it is obvious that the recent history of the more common birds and mammals of the Northern United States and Southern Canada does not even lend strength to the current, widespread belief that supplemental winter food supplies are essential to the continued production of annual surpluses of the different species of wildlife.

B. Experimental Evidence

In an attempt to gain additional information on the actual need for winter feeding, a series of physiological experiments involving a number

of different species of birds and mammals was undertaken. These were primarily concerned with the ability of the various forms to survive periods of stress, comparable to those which might be encountered during winters in the wild, without the benefits of nourishment from sources outside the animal body. A large percentage of them were fasts carried to fatal conclusions under environmental extremes.

Related Knowledge—Since the experimental activities dealt chiefly with the fasting powers of the various species, it appears wise briefly to discuss the related knowledge on the subject before proceeding either to describe the techniques utilized in the work or to present the data derived therefrom. Thus, a short summary of the more important phases of this vast field is presented in the paragraphs immediately following.

X In the first place, fasting, which may be defined as partial or complete abstinence from nourishment secured from sources outside the body, physiologically may be classed in some instances as normal, in others, abnormal.

Normal fasting occurs both in hibernating and in active animals. The long "winter sleep" of various reptiles and mammals, which is accompanied by no intake of external nourishment, is a phenomenon familiar to all. On the other hand, few persons realize that complete fasting is common among the adult stages of many active insects. Similarly, fish, such as the salmon, which partakes of no food during its migration to the breeding grounds, sometimes undergo a normal fast extending over a period of weeks. Likewise, some of the mammals also abstain from food for long periods of time. For example, the Alaskan fur seal bull is said not to eat during a breeding season lasting several months.

Pathological fasts, wherein the individual fails to secure nourishment, or cannot ingest, digest or assimilate that available, are of many kinds. Frequently they are partial or complete types due to unfavorable environmental conditions, such as severe winters with unusual accumulations of snow and ice, droughts, famines, wars or other social upheavals. Some of the most famous are voluntary human "hunger strikes" based on religious, political, or similar foundations.

Of particular interest in the present study, are the lengths of fasts recorded for various species of animals, including both those culminating in death as well as others not so ending. First to be considered are the records for man.

There are several famed cases of deliberate human fasting for political reasons. Possibly best known among those not ending in death was that carried out by Terence MacSwiney in 1919. Confined in a London jail, he fasted for 75 days before swooning and being forcibly fed. In 1929, a prisoner named Das went without food for a total of 61 days, perishing

at the end of that period. Also, one Taha Hussein, who attempted the assassination of an Egyptian government official, died in jail after 50 days without food. Similar are the recent, widely publicized fasts of Mohandas K. Ghandi.

Though not the longest on record, the laboratory fast of 31 days studied by Benedict (Benedict, 1915) represents a classic study in the field of human metabolism. This, of course, did not end in the death of the subject.

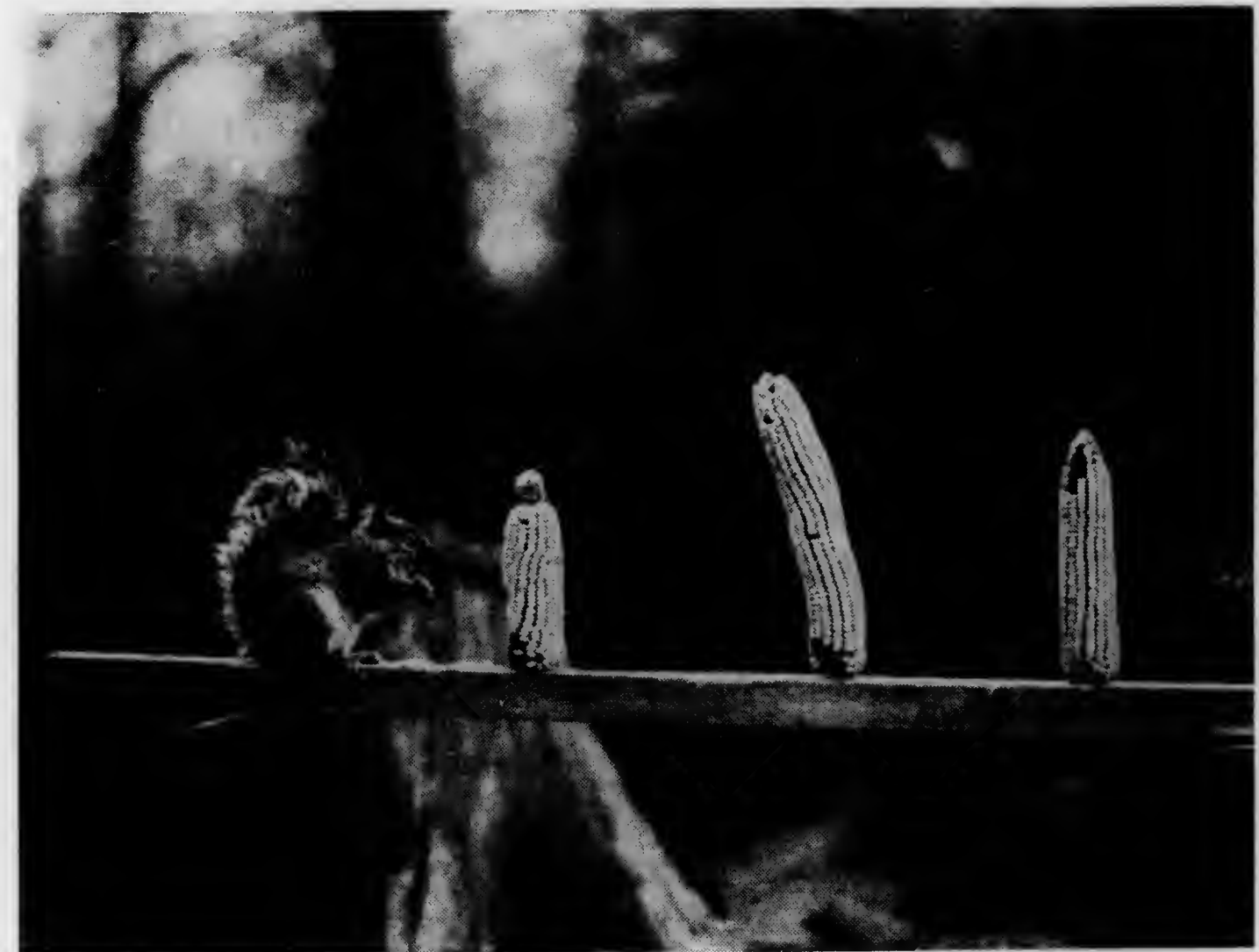


Figure 7. A grey squirrel eating at a spike pole feeder.

In addition to the human studies, the various metabolic investigations with other species have involved fasts of long duration. A Scotch collie, Oscar by name, underwent two unusually long fasts, one of 104 days, the other of 117 days, neither ending in death (Howe, Mattill and Hawk, 1912). Awrorow (cited by Phillips, Ashworth and Brody, 1932) carried out fasts leading to fatal conclusions with four dogs which survived for periods of 17, 45, 60 and 65 days. A prolonged fasting study on two swine, which survived for a period of between 60 and 70 days under somewhat unfavorable conditions, has also been reported (Johnson, 1932). The death of the two specimens was attributed to factors other than inanition. Metabolic tests with steers fasting up to 14 days have likewise been conducted (Benedict and Ritzman, 1927).

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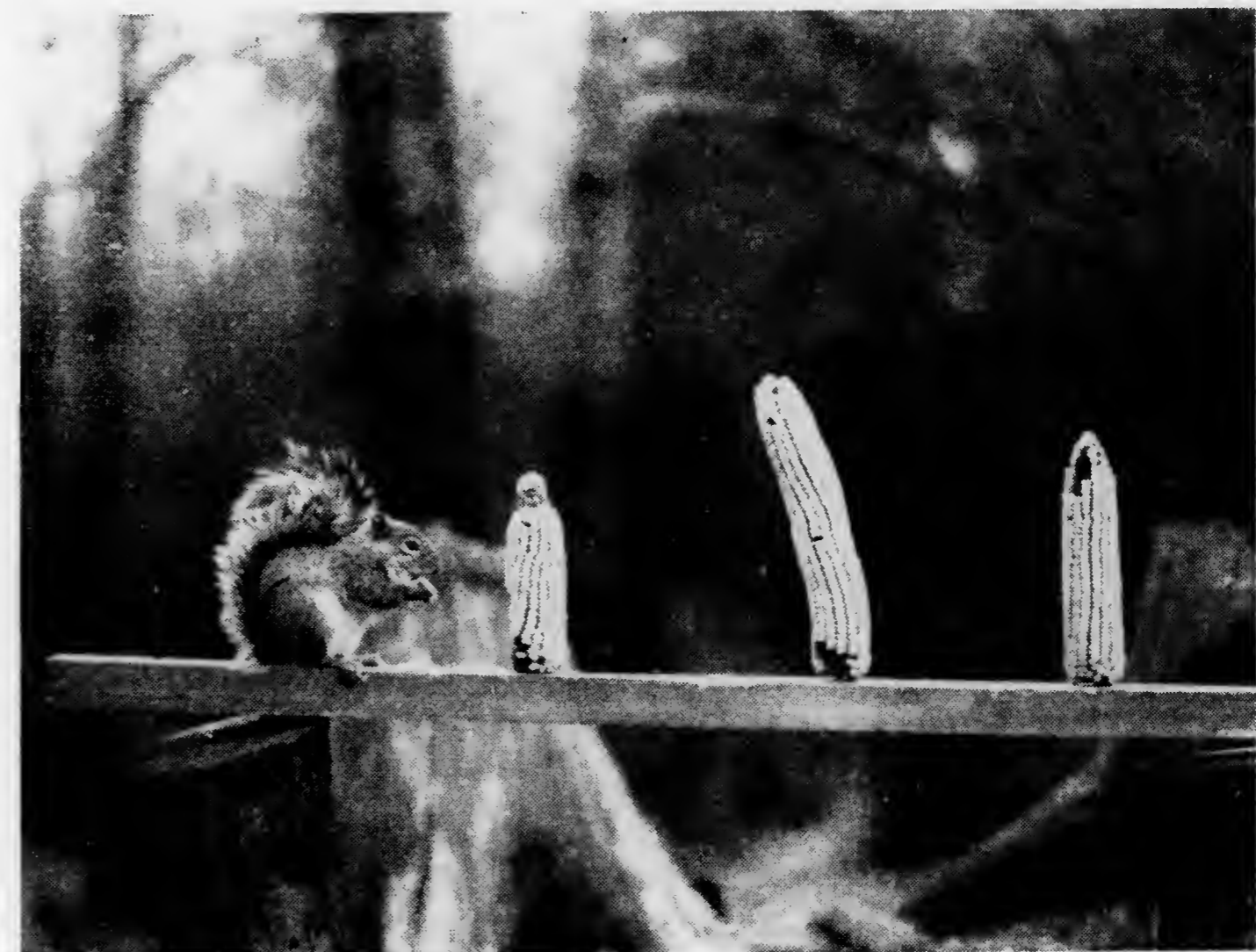


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In the case of the smaller mammals, long enduring fasts have also been recorded. For example, unusually large albino rats have undergone fatal fasts of 38 and 57 days (Benedict, Horst and Mendel, 1932), while mice have been known to live for nine days without food (Benedict and Lee, 1936).

Metabolic studies of many species of birds, including both wild and domestic varieties, have been made at various times and in various countries. A brief summary of most of these has been presented (Benedict and Fox, 1927). Certain of them have involved prolonged fasts. Domestic chickens have fasted up to 48 days (Phillips, Ashworth and Brody, *ibid.*), while other species have survived shorter periods without food. Among the smaller, wild, passerine species, English sparrows have been known to survive without food as long as 76 hours, whereas house wrens have lived over 30 hours without taking nourishment (Kendeigh, 1934).

In the case of game birds, with which this paper is largely concerned, comparatively little essentially basic research has been attempted. William H. Long started a series of longtime studies of this nature when a graduate student at the University of Michigan. He is now continuing the work at Cornell University as an agent of the U. S. Fish and Wildlife Service cooperating with the University and the State Conservation Department. Though few of his findings have as yet been published, the titles thereof have been listed (Wight, 1938). A New York report (Anonymous, 1937a) states that pheasants can survive without food for periods ranging from 10 to 19 days under temperatures fluctuating between 15° and 50°F. A more recent investigation (Errington, 1939) deals at some length with fasts of two weeks in the case of pheasants and of one week in the case of bobwhite quail.

Equal in importance to information on the fasting powers of the various species is that pertaining to the factors affecting such faculties. Since an animal's ability to survive without food is largely dependent upon its metabolic rate, we may assume that, in general, those same forces which influence the rate of animal metabolism also affect the power to exist without external supplies of nutrients. Thus, the most important of these are briefly outlined in the following paragraphs. Since the various species of birds and mammals would naturally be expected to vary in their fasting ability, the summarization deals with intra- rather than inter-specific influences. Furthermore, solely for simplification of the discussion, it is assumed that individual differences, such as variations in the amounts of stored fats, disease factors and the like, are non-existent.

Of the internal factors, in the first to be considered is that of race. In the case of humans, wide differences in the metabolism of various races have definitely been established (Benedict, 1937). Similarly, investiga-

tions on the heat production of several races of mice have not only established the existence of different metabolic rates, but also have revealed differences in ability to survive without food. Of four races studied, on the average, the "wilds" survived for 4 days; the "whites" 5 days; and the "heavies" and the "dwarfs," 9 days (Benedict and Lee, 1936). Even more closely related to the problem at hand has been the discovery of varied metabolic rates, as well as differences in responses to environmental stimuli, in two strains of wild turkeys (Gerstell and Long, 1939).

A second factor of importance is that of size. This may here be taken to include weight, stature and surface area. For example, in building up tables of metabolic rates for man, size had to be taken into consideration. In this case, the figures are on a weight-height basis. Among birds, the data are frequently presented with reference to surface area. Though the point possibly has not been definitely established, it has been stated that other factors being equal, the larger the animal the greater its ability to survive without food (Phillips, Ashworth and Brody, 1932). Along this line, the unusual fasting power of extremely large, but not fat, albino rats has been pointed out (Benedict, Horst and Mendel, 1932).

Age represents the third factor influencing metabolism and fasting power. A gradual lowering of metabolism with increasing age has been demonstrated in ring doves, pigeons, rats, sheep, cattle, swine, horses and man. Much of the pertinent data has been conveniently summarized (Brody, 1932). It has also been stated that age influences the time at which death occurs from starvation, young animals losing weight more rapidly and dying after a smaller loss of weight than old ones (Morrison, 1939).

Sex represents still another factor which must be considered. Sexual differentials in metabolic rates have long been known in man as well as numerous other forms of life. It was, however, not until 1930 that the existence of differential responses of the two sexes to varied environmental temperatures was reported for the ring dove (Riddle, Christman and Benedict, 1930). In some species, as will later be pointed out, there is a distinct difference in the ability of the two sexes to withstand environmental extremes, including food shortages. A report on this subject will appear shortly (Latham, 1941).

Numerous environmental factors also influence the primary life processes, as well as ability to undergo prolonged fasts. The first of these is season of the year. Seasonal variations in the basal metabolism have been reported for man. (Gustafson and Benedict, 1928), for pigeons (Riddle, Smith and Benedict, 1933) and for other species. Of particular interest is the discovery that sparrows in winter can survive identical low temperatures for longer periods than in summer (Kendeigh, 1934).

Environmental temperature also exerts a major influence on metabolism and the ability to survive without food. The great majority of the metabolic research to date conducted has been carried out within, or near, the zone of thermic neutrality. Among the notable exceptions have been the various investigations conducted over a wide range of environmental temperature by an European investigator. A number of these were concerned with temperatures of 32°F., while in several studies small mammals were even dipped in water at a temperature just above the freezing point (Giaja, 1925). Metabolism studies with the white rat have been conducted in a temperature range extending roughly from 25° to 64°F. (Benedict and MacLeod, 1929), while the effect of environmental temperatures ranging from about 42° to 60° upon the metabolic rates of pigeons has also been carefully investigated (Riddle, Smith and Benedict, *ibid.*). The average survival time of English sparrows fasting at 5.2°F. was found to be only 21.4 hours, while at 92.3° it was over 76 hours (Kendeigh, *ibid.*). Along the same lines, the importance of temperature in the winter killing of birds has been stressed by practically all workers.

Humidity is still another factor which must receive consideration. In the problem at hand, which is concerned in the main with comparatively low environmental temperatures, this is not of major importance, but in the higher temperature zones it is of particular significance. For example, the average time of survival for sparrows held at 104.0°F. with the relative humidity at 77.1% was only 3.3 hours, while with a slightly higher temperature with the humidity at only a fraction over 20%, the period of resistance was more than doubled (Kendeigh, *ibid.*).

Air movement appears to play a greater role in the survival of fasting birds and mammals than is commonly supposed. Thus, the subject will be discussed at some length in a subsequent section of this report. Light, doubtless through its effect on the activity of animals, also influences the metabolic rate, as well as the period of survival during fasts.

In summary, therefore, it may be said that the metabolic rates of the various species of birds and mammals, as well as the closely related power of enduring periods of fast, are influenced by nine principal factors. Four of these, race, size, age and sex, are inherent in the individual, while five, season, temperature, humidity, air movement and light, are of an environmental nature. Since all, as well as others of lesser importance, may occasionally act simultaneously upon any animal, or group of animals, under study and since all are rarely under absolute control of the investigator, it is practically impossible accurately to measure the effect of each single factor in each particular experiment.

Experimental Methods—In order to ascertain the actual need for winter feeding, it was necessary first of all to determine the ability of various species of birds and mammals to survive totally without benefit of nutri-

ents obtained outside the animal body. This was accomplished through the conduction of a series of fasting experiments, most of which were carried through to fatal conclusions.

—Secondly, it was considered essential to study the need for, as well as the utilization of, grit by game birds during the winter months. This was done by means of several investigations wherein experimental and control specimens were slaughtered and the contents of the intestinal tracts examined at regular intervals of time.

—Thirdly, an attempt was made to determine the effect of food shortages upon fecundity. This involved a careful comparison of the reproductive records of starved and unstarved groups of individuals of different species.

Finally, a number of points of lesser importance were all carefully checked during the course of the experiments. Among these were the effects of varied rates of air movement upon the period of survival of fasting animals and the need for water during the winter months.

Because of seasonal variations in animal metabolism and the consequent influence on ability to survive without external nutrients, which have previously been discussed, all experiments except those requiring breeding season fecundity tests were conducted only during the winter months under true or simulated winter conditions. In addition, all were of two principal types, namely, those conducted in the out-of-doors and those performed in the laboratory.

—The former involved the use of holding pens of wood and wire construction. In practically every instance, no protection from the elements was provided within the structures, though the tests were made under actual winter conditions, frequently most severe. In these investigations it was, of course, impossible to exert any control over meteorological factors of the environment, but accurate daily records of them were constantly maintained. For this purpose a complete weather station, including a checked thermograph, barograph, anemometer, rain gauge and related instruments, was set up in the immediate vicinity of the animal pens. Furthermore, though the experimental cages were all located within several hundred feet of the base station, additional instruments, such as maximum-minimum recording thermometers, were usually placed in or on the pens in close proximity to, but not where their operation could be effected by, the experimental animals.

—The laboratory tests were conducted in the climoactometer, a "weather chamber" wherein practically any desired combination of meteorological conditions could be simulated with a high degree of accuracy (Gerstell, 1938b). The device provides a compartment roughly 12 feet long, eight wide and five high. The temperature range within it is from —35° to +120° F. Winds are simulated by means of a rotary blower and a series of ducts which allow for constant air movement up to a maximum of 25

miles per hour. The humidity can be varied at will, while illumination is provided by lights of three special types. These are controlled by manually or automatically operated rheostats, thus allowing for effects similar to those produced by the rising and setting of the sun. Though not utilized in the work herein reported on, it is also possible by means of the apparatus to measure mechanically the activity of animals confined in the machine.

Unfortunately, it was impossible to conduct both the out-of-door and the laboratory fasts in exactly the same manner because of certain meteorological factors beyond human control. In the former, water in varying amounts was at times made available by rain, snow or sleet, but with few exceptions later to be discussed, the latter tests were of a type wherein neither food nor water was at any time offered the experimental specimens.

For both the outside and the indoor investigations, as well as other types, check, or control, specimens were provided for comparative purposes. In the out-of-door tests, such individuals were placed in pens immediately adjoining those containing the experimental animals, thus assuring identical environmental conditions for the two groups. In the case of the laboratory studies, the controls were confined in cages in the room housing the climoactometer. Since no precipitation could fall therein, since the temperature ranged from 35° to 50°F., since there was no appreciable air movement, since the humidity and barometric pressure varied roughly as in the open and since daylight and dark were simulated through the use of incandescent lamps burnt only during the normal working hours, it was felt that the conditions constantly existing in that space were roughly comparable to what might be termed "standard winter conditions" for the geographical regions with which this report is primarily concerned. It is recognized that this procedure is open to some criticism, but it was the best permitted by the facilities available.

- All animals, both experimentals and controls, in practically every experiment were weighed at intervals of twenty-four hours in order to gain some conception of the progress and effects of the fasts to which they were subjected. Because of the comparatively large numbers of individuals involved, together with working conditions frequently involving zero temperatures, wind, snow and rain, standard laboratory scales weighing in grams had to be discarded in favor of heavier, more easily and more rapidly operated equipment graduated in fractions of a pound (avoirdupois). By means of the latter, it was a comparatively simple matter rapidly to obtain records with maximum errors of less than one one-hundredth (1/100) of one pound. For more detailed laboratory work, such as weighing grit removed from the intestinal tract, highly sensitive, tested balances were employed.

- Visual checks of the animals under fast were made at least three times daily and frequently more often. During such inspections, any dead specimens were removed and proper data concerning them recorded. In the case of species with comparatively low survival powers, more frequent observations were made than with those forms known to be capable of fasting for long periods of time. This procedure made it possible to secure survival records believed to contain maximum errors of ± 6 hours. In most instances, the recorded error was but a small fraction of the maximum, while in a few cases the time of death was accurate to the minute as the specimen died in the hand. All in all, this does not represent an unusually high degree of accuracy, but it was the best which could be provided for. Also, with a minimum survival of 20, a maximum of 1,200 and an average of 240 hours, it was considered adequate for the purpose served.

In the laboratory experiments, certain methods of procedure had to be arbitrarily selected solely because of lack of precedent. For example, practically every test was run at 0°F. with various individuals exposed to different rates of air movement ("winds"), while the control specimens were subjected in the laboratory room to the "standard" conditions previously discussed. The zero temperature point was chosen because it represents environmental severity the relative position of which is readily visualized by scientist and layman alike. Air movement figures of 1.1 and 5.8 miles per hour were utilized both because they represented fixed velocities readily obtained by standard blower motor speeds and because they were considered comparable to the lower winds common to the natural habitats of the animals studied.

All other significant details of procedure are briefly outlined in those particular sections of this report to which they pertain. Any and all non-conformities to approved practices represented not desired but rather necessary departures therefrom.

For invaluable assistance in the experimental work, the writer is indebted to Roger M. Latham, his co-worker with the Pennsylvania Game Commission. Also, the cooperation of John D. Beule, another Commission employee, is acknowledged with thanks.

Ringneck Pheasant—Possibly best suited for initial discussion are those investigations for which the ringneck pheasant (*Phasianus colchicus torquatus*) was subject. This is due to the fact that the animal is one which lends itself well to experimentation, that a relatively large number of studies typical of those performed with other forms was carried out with the bird and that it is a game species for which many large-scale winter feeding programs are annually conducted.

First of all, a word regarding the types of stock used in the work is in order. Since, as previously discussed, it is definitely known that the

basal metabolism varies among different races of the same species and that the metabolic rate plays a major role in determining the length of time for which a given individual can survive without nourishment from outside its body, the importance of knowing the exact race, or strain, of animals dealt with becomes immediately obvious.

Throughout the researches herein reported, two principal races of many of the species treated were used in the experimental program. These were the so-called wild trapped, or wild caught, and the artificially propagated strains. The former was composed entirely of individuals hatched, or born, and usually reared in the wild state of wild parentage. The latter consisted of stock produced in captivity under artificial conditions, frequently representing the results of a number of generations of such propagation.

Since it is not within the province of this paper to discuss them, suffice it to say that studies by the writer and his co-worker, Roger M. Latham, inaugurated in 1938 and presently continuing, have definitely established the fact that wide differences in ability to survive periods of environmental stress frequently exist between the wild reared and artificially propagated strains of the same and different species of feral birds and mammals.

In view of the facts above mentioned, not only in the case of the pheasant, but in all other instances, especial care has been taken to provide detailed information both as to the type of stock used and, where possible, the ages of the members of each experimental group. The latter is important because it also affects fasting ability through its influence on metabolism.

As was the case with a number of other species, both out-of-door and laboratory tests were conducted with the pheasant. The experiment first to be discussed was of the former type. It was a fasting study involving a total of 50 mature birds of the artificially propagated type, all of which were approximately eight months of age. The outline of the work performed can doubtless be most readily understood if frequent reference be made to Table II, (opposite), which presents in summary form the data obtained.

First, from a group of several hundred ringnecks confined in out-of-door pens under identical conditions for a period of weeks prior to inauguration of the experiment, 50 mature, full-plumaged, healthy and uninjured birds of first quality were carefully selected. Every effort was made to secure specimens identical in all respects, except that one-half of the total were males, the other, females. For purposes of identification, each individual was marked with a numbered, aluminum leg band.

Second, the birds were divided into two groups of 25 each, as nearly as possible equal in all respects. One of these, containing 13 males and 12 females, was arbitrarily selected as the experimental lot, while the

Number		% of Initial Weight	% of Change in Weight
No. 54061		56.8%	-43.2%
No. 54055		45.7%	-54.3%
No. 54068		77.5%	-22.5%
No. 54059		64.6%	-35.4%
No. 54064		67.0%	-33.0%
No. 54040		58.9%	-41.1%
No. 54039		64.7%	-35.3%
No. 54054		53.3%	-46.7%
No. 54067		60.8%	-39.2%
No. 54051		79.4%	-20.6%
No. 54044		66.8%	-33.2%
No. 54052		70.0%	-30.0%
No. 54060		56.6%	-43.4%
No. 54056		70.2%	-29.8%
No. 54043		87.0%	-13.0%
No. 54058		49.8%	-50.2%
No. 54047	1.25D	58.7%	-41.3%
No. 54065		75.5%	-24.5%
No. 54053		70.8%	-29.2%
No. 54048		57.7%	-42.3%
No. 54063		72.6%	-27.4%
No. 54062		63.1%	-36.9%
No. 54049		52.0%	-48.0%
No. 54050		69.4%	-30.6%
No. 54042		60.8%	-39.2%
	Feb. 21	—	—
Number		% of Initial Weight	% of Change in Weight
No. 54086	2.68	77.2%	-22.8%
No. 54096	2.20	65.5%	-34.5%
No. 54073	3.04	95.0%	-5.0%
No. 54041	2.93	92.1%	-7.9%
No. 54079	3.38	108.0%	+8.0%
No. 54083	2.29	77.4%	-22.6%
No. 54093	2.71	69.5%	-30.5%
No. 54077			

TABLE II
FASTING EXPERIMENT—RINGNECK PHEASANT
(*Phasianus colchicus torquatus*)
Type Stock: Artificially propagated, approximately 8 months of age
EXPERIMENTAL SPECIMENS—WITHOUT FOOD—WATER USUALLY AVAILABLE

Number	Sex	Daily Weights (In Pounds)																				% of Initial Weight	% of Change in Weight	
No. 54061	M	3.47	3.46	3.39	3.33	3.27	3.27	3.23	3.18	3.13	3.11	3.07	3.02	2.99	2.97	2.84	2.56	2.30	2.08	1.97D	56.8%	-43.2%		
No. 54055	M	3.26	3.21	3.17	3.09	2.97	2.97	2.92	2.85	2.83	2.76	2.71	2.60	2.54	2.13	2.29	2.01	1.82	1.63	1.49D	45.7%	-54.3%		
No. 54068	M	3.06	3.02	2.96	2.83	2.79	2.79	2.77	2.68	2.67	2.64	2.60	2.50	2.47	2.38	2.37D					77.5%	-22.5%		
No. 54059	M	3.02	2.96	2.87	2.79	2.67	2.67	2.63	2.56	2.53	2.49	2.46	2.32	2.26	2.12	1.95D					64.6%	-35.4%		
No. 54064	M	3.00	2.95	2.89	2.85	2.75	2.75	2.71	2.66	2.60	2.53	2.52	2.34	2.23	2.08	2.01D					67.0%	-33.0%		
No. 54040	M	2.97	2.93	2.87	2.81	2.76	2.72	2.68	2.62	2.60	2.54	2.44	2.21	2.02	1.82	1.75D					58.9%	-41.1%		
No. 54039	M	2.95	2.87	2.83	2.79	2.76	2.73	2.72	2.62	2.60	2.55	2.50	2.34	2.24	2.04	1.91D					64.7%	-35.3%		
No. 54054	M	2.89	2.86	2.81	2.77	2.74	2.74	2.70	2.65	2.60	2.59	2.55	2.49	2.47	2.43	2.38	2.10	1.86	1.67	1.54D	53.3%	-46.7%		
No. 54067	M	2.88	2.84	2.80	2.76	2.67	2.67	2.65	2.57	2.51	2.37	2.24	2.03	1.92	1.75	1.75D					60.8%	-39.2%		
No. 54051	M	2.86	2.82	2.77	2.68	2.65	2.65	2.65	2.59	2.59	2.55	2.48	2.43	2.38	2.31	2.27D					79.4%	-20.6%		
No. 54044	M	2.83	2.79	2.74	2.67	2.65	2.60	2.59	2.55	2.51	2.48	2.44	2.31	2.23	2.07	1.89D					66.8%	-33.2%		
No. 54052	M	2.82	2.76	2.69	2.65	2.56	2.56	2.53	2.48	2.43	2.35	2.24	2.04	1.89	1.76	1.72D					70.0%	-30.0%		
No. 54060	M	2.72	2.63	2.58	2.55	2.45	2.45	2.41	2.32	2.26	2.13	2.00	1.81	1.70	1.54D					56.6%	-43.4%			
No. 54056	F	2.45	2.37	2.33	2.26	2.17	2.17	2.15	2.11	2.06	2.08	2.01	1.95	1.93	1.86	1.80	1.72D				70.2%	-29.8%		
No. 54043	F	2.31	2.26	2.22	2.18	2.15	2.10	2.06	2.01A												87.0%	-13.0%		
No. 54058	F	2.25	2.21	2.18	2.16	2.08	2.08	2.07	2.00	2.00	1.99	1.97	1.90	1.89	1.83	1.73	1.52	1.35	1.18	1.12D	49.8%	-50.2%		
No. 54047	F	2.13	2.10	2.09	2.05	2.03	2.01	1.99	1.98	1.95	1.94	1.93	1.88	1.87	1.87	1.86	1.75	1.69	1.60	1.59	1.43	58.7%	-41.3%	
No. 54065	F	2.12	2.09	2.05	2.02	1.93	1.93	1.92	1.88	1.87	1.84	1.82	1.75	1.73	1.68	1.60D					75.5%	-24.5%		
No. 54053	F	2.09	2.05	2.01	1.97	1.90	1.90	1.87	1.84	1.81	1.85	1.76	1.63	1.52	1.48D						70.8%	-29.2%		
No. 54048	F	2.08	2.04	2.01	1.97	1.94	1.94	1.92	1.88	1.87	1.88	1.85	1.79	1.78	1.75	1.69	1.53	1.40	1.23	1.20D	57.7%	-42.3%		
No. 54063	F	2.08	2.06	2.06	2.02	2.00	2.00	1.97	1.94	1.89	1.91	1.86	1.78	1.74	1.63	1.51D					72.6%	-27.4%		
No. 54062	F	1.98	1.96	1.96	1.92	1.88	1.88	1.86	1.83	1.81	1.79	1.69	1.60	1.50	1.37	1.25D					63.1%	-36.9%		
No. 54049	F	1.98	1.95	1.92	1.88	1.82	1.82	1.77	1.71	1.62	1.52	1.38	1.22	1.14	1.03D						52.0%	-48.0%		
No. 54050	F	1.93	1.88	1.87	1.84	1.77	1.77	1.75	1.73	1.69	1.69	1.66	1.60	1.53	1.40	1.34D					69.4%	-30.6%		
No. 54042	F	1.89	1.87	1.85	1.83	1.81	1.78	1.76	1.73	1.70	1.72	1.72	1.64	1.64	1.58	1.51	1.36	1.23	1.09	1.15D	60.8%	-39.2%		
		Feb. 1	Feb. 2	Feb. 3	Feb. 4	Feb. 5	Feb. 6	Feb. 7	Feb. 8	Feb. 9	Feb. 10	Feb. 11	Feb. 12	Feb. 13	Feb. 14	Feb. 15	Feb. 16	Feb. 17	Feb. 18	Feb. 19	Feb. 20	Feb. 21	—	—

CONTROL SPECIMENS—FOOD AND WATER CONSTANTLY AVAILABLE

Number	Sex	Weekly Weights (In Pounds)																				% of Initial Weight	% of Change in Weight	
No. 54086	M	3.47						3.50							3.49							2.68	77.2%	-22.8%
No. 54096	M	3.36						3.25							3.24							2.20	65.5%	-34.5%
No. 54073	M	3.20						3.16							3.17							3.04	95.0%	-5.0%
No. 54041	M	3.18						3.06							3.07							2.93	92.1%	-7.9%
No. 54079	M	3.13						3.13							3.11							3.38	108.0%	+8.0%
No. 54083	M	2.96						2.91							2.93							2.29	77.4%	-22.6%
No. 54093	M	2.93						2.96							3.02							2.71	92.5%	-7.5%
No. 54077	M	2.88						2.92							2.94							2.85	99.0%	-1.0%
No. 54074	M	2.81						2.90							3.00							2.95	105.0%	+5.0%
No. 54095	M	2.81						2.89							2.85							2.26	80.4%	-19.6%
No. 54094	M	2.77						2.83							2.85							3.07	110.8%	+10.8%
No. 54088	M	2.63						2.67							2.73							1.93	73.4%	-26.6%
No. 54036	F	2.53						2.44							2.38							2.20	87.0%	-13.0%
No. 54038	F	2.48						2.42							2.41							2.25	90.7%	-9.3%
No. 54098	F	2.37						2.37							2.41							2.26	95.4%	-4.6%
No. 54090	F	2.34						2.33							2.28							2.93	125.2%	+25.2%
No. 54087	F	2.30						2.36							2.37							2.16	93.9%	-6.1%
No. 54100	F	2.30						2.32							2.32							2.20	95.7%	-4.3%
No. 54045	F	2.12						2.15							2.14							2.06	97.2%	-2.8%
No. 54072	F	2.12						2.19							2.24							2.16	101.9%	+1.9%
No. 54091	F	2.07						2.04							2.06							2.71	130.9%	+30.9%
No. 54037	F	2.06						2.05							2.03							1.92	93.2%	-6.8%
No. 54046	F	2.04						2.15							2.12							2.04	100.0%	0.0%
No. 54066	F	2.00						2.02							1.96							1.96	98.0%	-2.0%
No. 54057	F	1.99						2.01							2.00							1.92	96.4%	-3.6%
		Feb. 1	Feb. 2	Feb. 3	Feb. 4	Feb. 5	Feb. 6	Feb. 7	Feb. 8	Feb. 9	Feb. 10	Feb. 11	Feb. 12	Feb. 13	Feb. 14	Feb. 15	Feb. 16	Feb. 17	Feb. 18	Feb. 19	Feb. 20	Feb. 21	—	—

TOTAL BODY WEIGHTS																								
Experimentals	---	64.02	62.94	61.84	61.67	59.17	58.95	58.28	56.97	54.09	53.30	51.90	49.18	47.61	45.18	39.42	14.55	11.65	10.48	10.06	1.43	1.25	—	—
Controls	-----	64.85	—	—	—	—	—	65.03	—	—	—	—	—	—	65.12	—	—	—	—	—	—	61.06	—	—
AVERAGE BODY WEIGHTS																								
Experimentals	---	2.56	2.52	2.47	2.47	2.37	2.36	2.33	2.28	2.25	2.20	2.16	2.05	1.98	1.88	1.88	1.82	1.66	1.50	1.44	1.43	1.25	63.8%	—36.2%
Controls	-----	2.59	—	—	—	—	—	2.60	—	—	—	—	—	—	2.60	—	—	—	—	—	—	2.44	93.8%	—6.2%
CHANGES IN AVERAGE BODY WEIGHTS																								
Experimentals	---	—	—,04	—,05	0.0	—,10	—,01	—,03	—,05	—,03	—,05	—,04	—,11	—,07	—,10	0.0	—,06	—,16	—,16	—,06	—,01	—,18	—	—
Controls	-----	—	—	—	—	—	—	+ ,01	—	—	—	—	—	—	0.0	—	—	—	—	—	—	—,16	—	—
DAILY EXTREMES IN ENVIRONMENTAL TEMPERATURE																								
Minimum	-----	12° F.	4° F.	2° F.	28° F.	24° F.	30° F.	33° F.	28° F.	23° F.	32° F.	34° F.	23° F.	31° F.	18° F.	18° F.	3° F.	3° F.	17° F.	27° F.	32° F.	25° F.	—	—
Maximum	-----	23° F.	24° F.	42° F.	39° F.	51° F.	42° F.	38° F.	39° F.	41° F.	38° F.	44° F.	46° F.	57° F.	30° F.	49° F.	32° F.	34° F.	53° F.	52° F.	40° F.	41° F.	—	—
DAILY FOOD CONSUMPTION (ENTIRE GROUP—IN POUNDS)																								
Controls	-----	—	—	1.55	2.06	2.37	2.63	2.53	2.13	2.32	2.70	2.54	2.29	2.40	—	—	1.68	1.98	2.47	2.73	2.66	2.40	—	—
DAILY PRECIPITATION																								
Rain(R) or snow(S)	-----	1.00"S	—	—	—	.01"R	—	.30"R	—	—	.07"R	.13"R	—	—	17.00"S	—	—	—	—	.72"R	.27"R	—	—	—
DAILY AIR MOVEMENT																								
Miles per 24 hours	—	—	—	—	68.1	14.9	11.0	11.1	63.3	21.0	16.3	58.8	3.0	27.4	92.5	174.8	95.0	58.6	36.6	29.9	36.7	147.1	—	—
		Feb. 1	Feb. 2	Feb. 3	Feb. 4	Feb. 5	Feb. 6	Feb. 7	Feb. 8	Feb. 9	Feb. 10	Feb. 11	Feb. 12	Feb. 13	Feb. 14	Feb. 15	Feb. 16	Feb. 17	Feb. 18	Feb. 19	Feb. 20	Feb. 21	—	—

other, composed of 12 males and 13 females, was used for check, or control, purposes. During the entire course of experimentation, each flock was confined in a separate pen of wood and wire construction. These were 36 feet square and six feet in height, with tops of two-inch mesh poultry netting. In them there was provided absolutely no protection from the elements.

Between nine and ten o'clock on the morning of February 1, 1940, which may be considered the start of the experiment, the body weights of all specimens were carefully determined and listed. As shown in the table above referred to, the range of weights in the experimental lot extended from a maximum of 3.47 to a minimum of 1.89 with an average of 2.56 pounds (avoirdupois). The corresponding figures for the control group were 3.47, 1.99 and 2.59 pounds. As food had been constantly before the birds since daylight on the morning on which the initial records were taken, it is assumed that all individuals had normally fed *ad libitum* and were at the time of weighing in a state of active digestion. The statistics, therefore, tend to indicate the equality of the two groups.

From 10.00 A. M., February 1, until the conclusion of the experiment on the morning of February 21, the experimental birds were provided with no food whatsoever, nor was any available to them within the pen. Water, in the form of rain and snow, was, however, usually readily obtainable. The control group was constantly supplied with food, in the form of a regular scratch grain mixture, and water of which they could partake *ad libitum*.

Since a fasting animal must depend for nourishment upon the chemical breakdown of its own body substances, its body weight, particularly when recorded at regular intervals of time, provides a reliable index of what might commonly be referred to as the "general physical condition" of the individual. In view of this fact, daily records of the body weights of all fasting specimens in this and other experiments were carefully obtained in order to gain information concerning the progress and effects of the fast. In some instances, the control specimens were also weighed at 24-hour intervals, but in other cases, such as the experiment under consideration, these data were gathered only weekly.

As would naturally be expected, the experimental birds exhibited losses in body weight throughout the entire course of experimentation. The average daily loss per bird varied with climatic conditions, ranging on a group basis from a high of 0.16 pounds (1 bird only) on February 19-20 to a low of less than 0.01 (25 birds) on February 3-4, with an average of 0.07 pounds per 24 hours. The corresponding figures for

individual specimens differ considerably from those for the entire group which are, of course, far more significant. For example, on February 9-10, female No. 54042 exhibited a gain of 0.02 pounds, while the group figure reflected a loss of 0.05 pounds per bird. Doubtless the gain recorded for the single hen was caused either by undetected dirt or water among the feathers or by the presence of an unusually large amount of snow or rain water ingested immediately before weighing.

On the other hand, the pheasants in the control group showed both gains and losses in body weight. For the entire lot, the average gain in



Figure 8. Placing ear corn in a basket feeder

body weight per bird from February 1 to 7 was 0.01 pounds. No change was reflected from February 7 to 14, while from February 14 to 21 there was an average loss of 0.16 pounds. In this case also there was wide variation between the figures for individuals and the averages for the entire group.

Of particular significance are the combined data on time of survival and percentage of weight loss of the fasting specimens. Study of the table will reveal the fact that, except for female No. 54043 which was accidentally killed on February 8, the first deaths, three in number, came

on February 14, after more than 12 days (300 hours) of fasting. An unusually severe blizzard had begun just before midnight on February 13. Accompanied by high winds and 17 inches of snowfall, the storm had caused the loss of 13 additional birds by the morning of February 15, or at almost the end of two full weeks (325 hours) without food. Among these 16 individuals, the maximum loss in body weight was 48% and the minimum 22.5%. The seventeenth pheasant succumbed on the following day, February 16, while six birds died on the eighteenth day (425 hours) with a maximum weight loss of over 54%. The remaining specimen died on the twentieth day (470 hours) at 58.7% of its initial body weight. Disregarding the accidentally killed individual, therefore, the average period of survival was just over 14 days (340 hours), with a minimum of over 12 days (290 hours) and a maximum of almost 20 days (470 hours). For the entire group, the average weight loss was 36.2% of the initial figure. In considering these data, the climatic conditions of the period should not be overlooked. There were six days of rain and two of snow, while the environmental temperatures ranged from 2° to 57°F.

The comparative group figures for the two lots of birds are also of interest. By February 7, the experimentals had lost 9% of their total initial weight, while their average body temperature, based on readings taken in the gizzards of 10 individuals picked at random from each group, was 108.5°F. On the other hand, the controls exhibited on the same date a gain of less than 1% of their initial weight, while their body temperature figure was 109.1°F.

By February 14, the experimental group had lost 26.8% of its starting weight, while its average body temperature had dropped to 103.7°F. In addition to the accidental death not included in the computations, three members of the lot died on this date. The control group showed for the same day a negligible gain in total body weight, together with an average body temperature of 108.5°F. In this connection, it is interesting to note that at the conclusion of the experiment on February 21, the control birds exhibited an average loss of 6.2% in body weight. The individual extremes ranged from a loss of 34.5% to a gain of 30.9%.

All the figures above discussed, as well as other data secured from the experiment, are presented in Table II, page 32.

During January and February of 1941, a second, similar, out-of-door fasting experiment was conducted with ringneck pheasants. This involved a total of 25 live-trapped females of unknown ages, but with a minimum life of 20 months. All had been held captive for approximately one year prior to inauguration of the test.

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All the figures above discussed, as well as other data secured from the experiment, are presented in Table II, page 32.

During January and February of 1941, a second, similar, out-of-door fasting experiment was conducted with ringneck pheasants. This involved a total of 25 live-trapped females of unknown ages, but with a minimum life of 20 months. All had been held captive for approximately one year prior to inauguration of the test.

The birds were leg-banded, weighed, and placed in a pen 36 feet square on January 4, 1941. The structure provided no protection from the elements. No food was available at any time, though water could usually be obtained in the form of snow. The specimens were weighed at intervals of one week up to and including February 8, 1941. The data secured are presented in Table III, page 37.

At the beginning of the experiment, the weight range of the birds extended from 3.07 to 2.30 pounds, with an average of 2.66 pounds. By January 11, there had been an average loss of 9.4% of the initial weights. The maximum had dropped to 2.81 pounds, the minimum to 2.04 and the average to 2.41 pounds. At the end of the second week, January 18, the birds exhibited an average loss of 16.6% of their initial weights, while the maximum, minimum and average figures were 2.65, 1.73 and 2.22 pounds, respectively. The first pheasant, number 23, was found dead on January 20, the sixteenth day (372 hours) of fasting, at 70.4% of its initial weight. The second bird, number 22, perished on the twenty-first day (492 hours), having lost 31.9% of its starting weight. The 23 birds living at the end of three weeks (504 hours) without food, had lost 24.7% of their initial weight. The heaviest specimen weighed 2.42 pounds and the lightest 1.56 pounds. The average weight was 2.03, while the maximum and minimum losses in weight were, respectively, 34.9% and 19.6%. Five additional birds perished during the fourth week of fasting at points ranging from 47.8% to 73.3% of their starting weights. At the end of four weeks (672 hours), the 18 living birds weighed a total of 33.84 pounds, or 69.1% of their starting weight. The individual figures ran from 2.31 to 1.40, with an average of 1.88 pounds. Five more birds succumbed during the fifth week of experimentation, exhibiting weight losses from 50.0% to 58.1%. After five full weeks, or 35 days (840 hours), without food, 13 individuals were still alive and well able to fly and otherwise take care of themselves! They had lost in all 42.3% of their weight of January 4. Among the individuals, the maximum weight was 1.99, the minimum 1.12 and the average 1.61 pounds. Though one bird had lost only 34.0% of its starting weight, the total for one hen was 57.9%, while three others also weighed less than one half their weight at the beginning of the experiment.

In connection with the figures just discussed, it is important to note carefully the meteorological data presented. The period during which the experiment was conducted was unusually severe. Though there were no periods of extremely low temperature or continued high winds, it rained once and snowed frequently, while the hours when the temperature was above the freezing point were comparatively few in number.

In comparing the first experiment described with that just discussed, the differences in survival time become immediately obvious. Just why

TABLE III
FASTING EXPERIMENT—RINGNECK PHEASANT
(*Phasianus colchicus torquatus*)

Type Stock: Wild trapped, unknown ages with minimum of 7 months.

Period Ending (1941)	Jan. 4	January 11		January 18		January 25		February 1		February 8	
Specimen Number	B. Wght.	B. Wght.	% Loss (A)	B. Wght.	% Loss (A)	B. Wght.	% Loss (A)	B. Wght.	% Loss (A)	B. Wght.	% Loss (A)
No. 1	3.07 lbs.	2.81 lbs.	8.5%	2.62 lbs.	14.7%	2.39 lbs.	22.1%	(B)	—	1.99 lbs.	34.8%
No. 2	3.05 lbs.	2.80 lbs.	8.2%	2.65 lbs.	13.1%	2.42 lbs.	20.7%	2.31 lbs.	24.3%	1.72 lbs.	42.3%
No. 3	2.98 lbs.	2.72 lbs.	8.7%	2.52 lbs.	15.4%	2.25 lbs.	24.5%	2.06 lbs.	30.9%	1.94 lbs.	34.0%
No. 4	2.94 lbs.	2.73 lbs.	7.1%	2.52 lbs.	14.3%	2.31 lbs.	21.4%	2.19 lbs.	25.5%	1.84 lbs.	36.8%
No. 5	2.91 lbs.	2.69 lbs.	7.6%	2.52 lbs.	13.4%	2.32 lbs.	20.3%	2.13 lbs.	26.8%	(C)	—
No. 6	2.86 lbs.	2.61 lbs.	7.7%	2.43 lbs.	15.1%	2.14 lbs.	25.2%	1.93 lbs.	32.6%	1.33 lbs.	52.8%
No. 7	2.82 lbs.	2.53 lbs.	10.3%	2.33 lbs.	17.4%	2.12 lbs.	24.8%	1.93 lbs.	31.6%	1.61 lbs.	41.5%
No. 8	2.75 lbs.	2.44 lbs.	11.3%	2.24 lbs.	18.5%	2.01 lbs.	26.9%	1.87 lbs.	32.0%	(D)	—
No. 9	2.72 lbs.	2.42 lbs.	11.0%	2.17 lbs.	20.2%	1.91 lbs.	29.8%	1.40 lbs.	48.5%	1.73 lbs.	35.9%
No. 10	2.70 lbs.	2.48 lbs.	8.1%	2.30 lbs.	14.8%	2.12 lbs.	22.5%	2.00 lbs.	25.9%	1.69 lbs.	37.2%
No. 11	2.69 lbs.	2.44 lbs.	9.3%	2.30 lbs.	14.5%	2.03 lbs.	22.7%	1.97 lbs.	26.8%	—	—
No. 12	2.68 lbs.	2.41 lbs.	10.4%	2.26 lbs.	16.0%	2.02 lbs.	24.9%	(E)	—	—	—
No. 13	2.68 lbs.	2.44 lbs.	9.0%	2.27 lbs.	15.3%	2.02 lbs.	24.6%	1.89 lbs.	29.5%	1.62 lbs.	39.6%
No. 14	2.68 lbs.	2.44 lbs.	9.0%	2.31 lbs.	13.8%	2.14 lbs.	20.1%	2.00 lbs.	25.4%	1.75 lbs.	34.7%
No. 15	2.66 lbs.	2.40 lbs.	9.8%	2.23 lbs.	16.5%	2.00 lbs.	22.6%	1.83 lbs.	31.2%	1.12 lbs.	57.9%
No. 16	2.66 lbs.	2.41 lbs.	9.4%	2.24 lbs.	15.8%	2.06 lbs.	24.8%	1.78 lbs.	34.1%	1.30 lbs.	51.1%
No. 17	2.65 lbs.	2.48 lbs.	6.4%	2.32 lbs.	12.5%	2.13 lbs.	19.6%	1.94 lbs.	26.8%	1.24 lbs.	53.2%
No. 18	2.55 lbs.	2.27 lbs.	11.0%	2.05 lbs.	19.6%	1.66 lbs.	34.9%	(F)	—	(G)	—
No. 19	2.51 lbs.	2.30 lbs.	8.4%	2.11 lbs.	15.9%	1.90 lbs.	24.3%	1.68 lbs.	33.1%	(H)	—
No. 20	2.33 lbs.	2.16 lbs.	9.2%	1.98 lbs.	16.8%	1.77 lbs.	25.6%	1.53 lbs.	35.7%	(I)	—
No. 21	2.37 lbs.	2.14 lbs.	9.3%	1.91 lbs.	19.4%	1.62 lbs.	32.6%	(J)	—	—	—
No. 22	2.35 lbs.	2.11 lbs.	10.2%	1.88 lbs.	20.0%	1.56 lbs.	32.5%	(L)	—	—	—
No. 23	2.33 lbs.	2.05 lbs.	12.0%	1.73 lbs.	25.8%	1.63 lbs.	27.0%	1.40 lbs.	39.1%	(M)	—
No. 24	2.31 lbs.	2.04 lbs.	11.7%	1.83 lbs.	20.8%	—	—	—	—	—	—
No. 25	2.30 lbs.	2.05 lbs.	10.9%	1.87 lbs.	18.7%	—	—	—	—	—	—
Average per bird (N)	2.66 lbs.	2.41 lbs.	9.4%	2.22 lbs.	16.6%	2.03 lbs.	24.7%	1.88 lbs.	30.9%	1.61 lbs.	42.3%
TEMPERATURE											
Minimum	—	10° F.	6° F.	2° F.	7° F.	1° F.					
Maximum	—	35° F.	35° F.	38° F.	37° F.	40° F.					
PRECIPITATION											
Inches of Rain (O)	—	0.2 in.	0.7 in.	1.5 in.	0.5 in.	0.2 in.					
Inches of snow	—	1.8 in.	4.2 in.	7.5 in.	6.1 in.	0.5 in.					
AIR MOVEMENT											
Average per 24 hours	—	3.4 mls.	4.3 mls.	5.8 mls.	2.6 mls.	5.8 mls.					

Notes: All birds without food or shelter at all times. Water usually available in the form of snow or rain. All birds females.
(A)—Represents percentage of initial body weight (January 4) lost.
(B)—Bird died January 30; body weight—1.17 lbs.; % loss—50.6%.
(C)—Bird died January 25; body weight—1.60 lbs.; % loss—31.9%.
(D)—Bird died January 20; body weight—1.64 lbs.; % loss—29.6%.
(E)—Bird died January 30; body weight—1.32 lbs.; % loss—42.9%.
(F)—Bird died January 4; body weight—1.08 lbs.; % loss—53.0%.
(G)—Bird died February 6; body weight—1.18 lbs.; % loss—53.0%.
(H)—Bird died February 4; body weight—1.19 lbs.; % loss—50.0%.
(I)—Bird died January 30; body weight—1.17 lbs.; % loss—50.6%.
(J)—Bird died January 25; body weight—1.60 lbs.; % loss—31.9%.
(K)—Bird died January 20; body weight—1.64 lbs.; % loss—29.6%.
(L)—Bird died January 30; body weight—1.32 lbs.; % loss—42.9%.
(M)—Bird died February 4; body weight—1.08 lbs.; % loss—53.0%.
(N)—Figures include only those of live birds.
(O)—Includes all snow melted to water.

the birds in the second test should endure so much longer under more severe environmental conditions than those in the first run is not definitely known. As will later be discussed, there is, however, every reason to believe that the difference is due at least in part to the greater ability of wild stock to survive stress and to the fact that the second lot of birds were older than the first.



Figure 9. A partially plucked ringneck pheasant cock, illustrating the extreme emaciation exhibited by birds which have undergone fasts carried to fatal conclusions.

A third fasting experiment involving the ringneck was conducted during March, 1940. This was a combination out-of-doors and laboratory experiment involving nine artificially propagated birds approximately nine months of age.

On March 1, all nine birds were weighed and placed in an out-of-door pen without food or cover, but where water was usually available in the form of snow or rain. At the end of 10 full days (240 hours) of fasting, the birds were caught up, weighed and divided in the order of capture into three groups, each containing two males and one female. The first group, which had lost 15.9% of its initial weight, was placed in the climoactometer at 0°F. with a constant air movement of 5.8 miles per hour. The second lot, exhibiting a weight loss of 21.2%, was placed in the chamber also at 0°F., but where no "wind" reached the birds. The

remaining three individuals were confined in cages in the laboratory room where the "standard" conditions previously discussed were assumed to prevail. Both food and water were denied all birds and they were fasted until death. The data obtained from the experiment are listed in Table IV, page 40.

Examination of the figures reveals the fact that the individuals in the first group survived from less than two to almost three days (approximately 40 to 65 hours), with an average of roughly two and one-half days (60 hours). The weight loss, from the beginning of the experiment on March 1, was 26.7% for the entire group. The second lot perished in from not quite one to nearly seven days (about 20 to 160 hours), or after an average of three and one-half days (84 hours). The total weight loss for the group was 41.7%. The remaining three birds, which exhibited a total loss of 14.9% in body weight when placed in the laboratory room on March 11, succumbed on the tenth, eleventh and twelfth days, or at an average of about 11 days (264 hours). The group perished at 44.6% of its weight on March 1. If the 10 days of fast preceeding the date the birds were placed in the chamber or laboratory room be added to the figures just given, the average period of survival for the three groups becomes 12.5, 13.5 and 21 days. (300, 324 and 504 hours).

Additional pheasant experiments of different types are described elsewhere. It is, however, felt that those just discussed will serve as examples of the tests run with other species which are later described in lesser detail.

From the data above presented, it is obvious that the ringneck pheasant is a relatively hardy species which can doubtless endure *wholly without food* 10 or more days of severe winter weather, suffering very little in consequence thereof. It must, however, be remembered that under extremely unusual meteorological conditions, such as those occurring in the 1940 Armistice Day storm, even pheasants may suffer heavy losses *regardless of food conditions*.

— **Wild Turkey**—An out-of-door experiment involving a pair of birds and a laboratory test with six individuals were simultaneously performed with the wild turkey (*Meleagris gallopavo silvestris*) in March, 1940.

In the laboratory test, one pair of birds was fasted at 0°F. with a constant "wind" of 5.8 miles per hour, another at 0°F. with no air movement and the third under the "standard" conditions provided in the laboratory room. For the out-of-door investigation, two birds were confined in open pens without food and offering no protection from the elements. The first three groups had access to no water, but the last mentioned pair frequently secured it in the form of snow or rain. The data resulting from the work are given in Table V, page 41.

the birds in the second test should endure so much longer under more severe environmental conditions than those in the first run is not definitely known. As will later be discussed, there is, however, every reason to believe that the difference is due at least in part to the greater ability of wild stock to survive stress and to the fact that the second lot of birds were older than the first.



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A third fasting experiment involving the ringneck was conducted during March, 1940. This was a combination out-of-doors and laboratory experiment involving nine artificially propagated birds approximately nine months of age.

On March 1, all nine birds were weighed and placed in an out-of-door pen without food or cover, but where water was usually available in the form of snow or rain. At the end of 10 full days (240 hours) of fasting, the birds were caught up, weighed and divided in the order of capture into three groups, each containing two males and one female. The first group, which had lost 15.9% of its initial weight, was placed in the climoactometer at 0°F. with a constant air movement of 5.8 miles per hour. The second lot, exhibiting a weight loss of 21.2%, was placed in the chamber also at 0°F., but where no "wind" reached the birds. The

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From the data above presented, it is obvious that the ringneck pheasant is a relatively hardy species which can doubtless endure *wholly without food* 10 or more days of severe winter weather, suffering very little in consequence thereof. It must, however, be remembered that under extremely unusual meteorological conditions, such as those occurring in the 1940 Armistice Day storm, even pheasants may suffer heavy losses *regardless of food conditions*.

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TABLE IV
FASTING EXPERIMENT—RINGNECK PHEASANT
(*Phasianus colchicus torquatus*)

Type Stock: Artificially propagated, approximately 9 months of age.

Dates	B. Wt. No. 1 M	B. Wt. No. 2 F	B. Wt. No. 3 M	B. Wt. No. 4 F	B. Wt. No. 5 M	B. Wt. No. 6 F	B. Wt. No. 7 M	B. Wt. No. 8 F	B. Wt. No. 9 M
Mar. 1, 1940--	2.88 lbs.	2.83 lbs.	1.94 lbs.	2.91 lbs.	2.89 lbs.	1.92 lbs.	3.16 lbs.	3.06 lbs.	2.10 lbs.
From 10:00 A. M. March 1 to 10 A. M. March 11 all birds fasted in out-of-doors p.n. Env. Temps. from 9° to 67° F.									
Mar. 11, 1940--	2.41 lbs.	2.35 lbs.	1.67 lbs.	2.12 lbs.	2.49 lbs.	1.47 lbs.	2.70 lbs.	2.50 lbs.	1.79 lbs.
% loss in weight	16.3%	17.0%	13.9%	27.2%	13.8%	23.5%	14.6%	15.4%	14.8%
Dates	Env. Temp.—0° F.	Air Mov.—5.8 M.P.H.	Env. Temp.—0° F.	Air Mov.—0	Env. Temp.—33° to 50° F.	Air Mov.—0			
Mar. 11, 1940 --	2.41 lbs.	2.35 lbs.	1.67 lbs.	2.12 lbs.	2.49 lbs.	1.47 lbs.	2.70 lbs.	2.50 lbs.	1.79 lbs.
Mar. 12, 1940 --	2.31 lbs.	2.19 lbs.	1.64 lbs.	1.93 lbs.	2.43 lbs.	1.34 lbs. D	2.65 lbs.	2.54 lbs.	1.75 lbs.
Mar. 13, 1940 --	2.23 lbs.	2.11 lbs. D	1.52 lbs.	1.71 lbs.	2.35 lbs.		2.59 lbs.	2.45 lbs.	1.69 lbs.
Mar. 14, 1940 --	2.12 lbs. D		1.38 lbs. D	1.60 lbs. AD	2.25 lbs.		2.50 lbs.	2.35 lbs.	1.60 lbs.
Mar. 15, 1940 --					2.11 lbs.		2.42 lbs.	2.28 lbs.	1.52 lbs.
Mar. 16, 1940 --					1.96 lbs.		2.38 lbs.	2.23 lbs.	1.45 lbs.
Mar. 17, 1940 --					1.75 lbs.		2.26 lbs.	2.08 lbs.	1.34 lbs.
Mar. 18, 1940 --					1.56 lbs. D		2.14 lbs.	1.94 lbs.	1.21 lbs.
Mar. 19, 1940 --							1.98 lbs.	1.77 lbs.	1.04 lbs.
Mar. 20, 1940 --							1.84 lbs.	1.59 lbs.	.93 lbs.
Mar. 21, 1940 --							1.70 lbs.	1.44 lbs.	.89 lbs. D
Mar. 22, 1940 --							1.59 lbs.	1.35 lbs. D	
Mar. 23, 1940 --							1.47 lbs. D		

Notes: During out-of-doors fast, water was usually available in the form of rain or snow.

In laboratory birds had neither food nor water.

A—Bird actually died 8:00 P. M. March 13.

D—Indicates dead bird.

Percentages of initial body weights lost up to time of death: No. 1—26.4%, No. 2—25.5%, No. 3—28.9%, No. 4—45.0%, No. 5—46.1%, No. 6—30.2%, No. 7—53.5%, No. 8—55.1%, No. 9—57.6%.

TABLE V
FASTING EXPERIMENTS—WILD TURKEY
(*Meleagris gallopavo silvestris*)

Type Stock: Artificially propagated, approximately 9 months of age.

Dates	Laboratory Tests				Out-of-Doors Test			
	Environmental Temperature—0° F.				(In Unsheltered Pen)			
	Air Mov. 5.8 M.P.H.		Air Mov.—0		Air Movement—0		Body Weights	
	B. Wt. No. 1 M	B. Wt. No. 2 F	B. Wt. No. 3 M	B. Wt. No. 4 F	B. Wt. No. 5 M	B. Wt. No. 6 F	B. Wt. No. 7 M	B. Wt. No. 8 F
Mar. 2, 1940	11.93 lbs.	7.42 lbs.	14.06 lbs.	7.39 lbs.	9.51 lbs.	7.86 lbs.	11.21 lbs.	9.45 lbs.
Mar. 3, 1940	11.75 lbs.	7.29 lbs.	13.76 lbs.	7.38 lbs.	9.31 lbs.	7.70 lbs.	10.72 lbs.	9.20 lbs.
Mar. 4, 1940	11.53 lbs.	7.13 lbs.	13.52 lbs.	7.19 lbs.	9.08 lbs.	7.50 lbs.	10.44 lbs.	8.95 lbs.
Mar. 5, 1940	11.39 lbs.	6.84 lbs.	13.29 lbs.	7.03 lbs.	8.67 lbs.	7.39 lbs.	10.07 lbs.	8.68 lbs.
Mar. 6, 1940	11.09 lbs.	6.53 lbs.	13.02 lbs.	6.89 lbs.	8.35 lbs.	7.18 lbs.	9.66 lbs.	8.44 lbs.
Mar. 7, 1940	10.65 lbs.	6.22 lbs.	12.82 lbs.	6.77 lbs.	7.94 lbs.	6.93 lbs.	9.21 lbs.	8.22 lbs.
Mar. 8, 1940	10.27 lbs.	5.89 lbs.	12.65 lbs.	6.64 lbs.	7.48 lbs.	6.70 lbs.	8.65 lbs.	8.10 lbs.
Mar. 9, 1940	9.53 lbs.	5.74 lbs. D	12.26 lbs.	6.51 lbs.	7.12 lbs. A	6.51 lbs.	8.06 lbs.	7.80 lbs.
Mar. 10, 1940	8.80 lbs.		12.15 lbs.	6.27 lbs.		6.49 lbs.	7.32 lbs.	7.07 lbs.
Mar. 11, 1940	8.63 lbs. D		11.90 lbs.	6.02 lbs.		6.49 lbs.	7.12 lbs. D	7.07 lbs.
Mar. 12, 1940			11.72 lbs.	5.60 lbs.		6.39 lbs.	7.07 lbs.	7.07 lbs.
Mar. 13, 1940			11.41 lbs.	5.24 lbs. D		6.27 lbs.	7.07 lbs.	7.07 lbs.
Mar. 14, 1940			11.16 lbs.			6.14 lbs.	7.07 lbs.	7.07 lbs.
Mar. 15, 1940			10.74 lbs.			5.94 lbs.	7.07 lbs.	7.07 lbs.
Mar. 16, 1940			10.14 lbs.			5.77 lbs.	7.07 lbs.	7.07 lbs.
Mar. 17, 1940			9.63 lbs.			5.63 lbs.	7.07 lbs.	7.07 lbs.
Mar. 18, 1940			9.31 lbs. D			5.42 lbs.	7.07 lbs.	7.07 lbs.
Mar. 19, 1940						5.22 lbs.	7.07 lbs.	7.07 lbs.
Mar. 20, 1940						4.98 lbs.	7.07 lbs.	7.07 lbs.
Mar. 21, 1940						4.68 lbs.	7.07 lbs.	7.07 lbs.
Mar. 22, 1940						4.43 lbs.	7.07 lbs.	7.07 lbs.
Mar. 23, 1940						4.15 lbs.	7.07 lbs.	7.07 lbs.
Mar. 24, 1940						3.86 lbs. D	7.07 lbs.	7.07 lbs.
Mar. 25, 1940								
Mar. 26, 1940								

Notes: All birds in laboratory tests without food or water at all times.

All birds in out-of-doors test without food at all times, but water, in the form of snow or rain, was available at practically all times.

A—Bird died as result of breaking thermometer inserted in throat.

B—Bird soaked by heavy rain doubtless causing increase in recorded weight.

C—Light rain fell on this date.

D—Indicates dead bird.

Percentages of initial body weights lost up to time of death: No. 1—27.7%, No. 2—22.6%, No. 3—33.8%, No. 4—29.1%, No. 5—25.9%, No. 6—50.9%, No. 7—36.5%, No. 8—49.9%.

Examination of the statistics shows that the two birds at zero with the "wind" survived almost seven and nine days (roughly 160 and 210 hours), or an average of eight days (192 hours). Their total weight loss was 25.7% of the initial figure. The pair at zero protected from all air movement lived just less than 11 and almost 16 days (approximately 260 and 370 hours), with an average of 13.5 days (324 hours). They perished at 67.8% of their total initial weight. As indicated, one of the control birds was accidentally killed at the end of one week (168 hours), but the other survived approximately 24 days (576 hours), dying at 57.7% of its initial weight. The out-of-door pair survived nine and 19 days (210 and 456 hours), or an average of 14 days (336 hours). Their total weight loss was 42.4%.

The experiments just described serve to establish the fact that the turkey, like the pheasant, is also a comparatively hardy species capable of enduring at least one week of severe winter weather without food, but still suffering no serious ill effects from so doing. Extremely unusual combinations of conditions may, however, cause losses from exposure even with an abundance of food.

Bobwhite Quail—A total of 38 bobwhite quail (*Colinus virginianus virginianus*) was utilized in a laboratory experiment performed in March, 1941. All were artificially propagated birds from nine to 10 months of age. The test was designed in part to show the importance of covey size in relation to the species' ability to survive periods of environmental stress.

A lot of 10 quail, each separately confined in individual cages, was fasted at 0°F. under a constant wind of 5.8 miles per hour. Two groups of birds, each containing 10 specimens in equal numbers as to sex, were held without food or water at 0°F. with no air movement. The important difference in procedure was that in one instance these birds were singly confined in separate cages as in most other experiments, while in the other all 10 were placed in one large cage in which they could "huddle" in the normal manner. In addition, four males and four females were subject to fast under the "standard" conditions of the laboratory room. The data obtained are summarized in Table VI, page 43.

The birds "in the wind" at zero survived from less than one to almost three days (roughly 20 to 65 hours), or an average of 1.9 days (46 hours). The minimum loss in body weight was 11.4%, the maximum was 26.4% and the group figure 17.0%. The individually confined birds held at zero with "no wind" lived from not quite one to three and three-quarters days (20 to 90 hours), with an average of 2.5 days (60 hours). The weight losses ranged from 7.9% to 31.5%, with a group total of 23.7%. In comparison, the third group, held under identical temperature and air movement, but provided opportunity to huddle in characteristic circular

TABLE VI
FASTING EXPERIMENT—BOBWHITE QUAIL
(*Colinus virginianus virginianus*)
Type Stock: Artificially propagated, 9 to 10 months of age.

Dates	B. Wt. No. 1 M	B. Wt. No. 2 F	B. Wt. No. 3 M	B. Wt. No. 4 F	B. Wt. No. 5 M	B. Wt. No. 6 F	B. Wt. No. 7 F	B. Wt. No. 8 M	B. Wt. No. 9 M	B. Wt. No. 10 F
LOT 1—ENVIRONMENTAL TEMPERATURE—0° F. AIR MOVEMENT—5.8 M.P.H. BIRDS INDIVIDUALLY CONFINED										
Mar. 27, 1941	0.37 lbs.	0.37 lbs.	0.38 lbs.	0.38 lbs.	0.35 lbs.	0.36 lbs.	0.38 lbs.	0.35 lbs.	0.38 lbs.	0.33 lbs.
Mar. 28, 1941	0.34 lbs.	0.35 lbs.	0.33 lbs.	0.33 lbs.	0.33 lbs.	0.32 lbs.	0.35 lbs.	0.31 lbs.	0.35 lbs.	0.29 lbs.
Mar. 29, 1941	0.30 lbs.	0.30 lbs.	0.31 lbs.	0.32 lbs.	0.30 lbs.	0.31 lbs.	0.31 lbs.	0.28 lbs.	0.31 lbs.	AD
Mar. 30, 1941	0.29 lbs.	0.30 lbs.	0.31 lbs.	0.32 lbs.	0.30 lbs.	0.30 lbs.	0.28 lbs.	0.28 lbs.	0.31 lbs.	AD
LOT 2—ENVIRONMENTAL TEMPERATURE—0° F. AIR MOVEMENT—0. BIRDS INDIVIDUALLY CONFINED										
Mar. 27, 1941	0.43 lbs.	0.42 lbs.	0.37 lbs.	0.34 lbs.	0.36 lbs.	0.33 lbs.	0.38 lbs.	0.35 lbs.	0.29 lbs.	0.35 lbs.
Mar. 28, 1941	0.41 lbs.	0.39 lbs.	0.36 lbs.	0.30 lbs.	0.33 lbs.	0.35 lbs.	0.35 lbs.	0.32 lbs.	0.26 lbs.	0.31 lbs.
Mar. 29, 1941	0.37 lbs.	0.34 lbs.	0.31 lbs.	0.28 lbs.	0.29 lbs.	0.32 lbs.	0.32 lbs.	0.23 lbs.	0.26 lbs.	0.26 lbs.
Mar. 30, 1941	0.33 lbs.	0.29 lbs.	0.27 lbs.	0.27 lbs.	0.27 lbs.	0.27 lbs.	0.23 lbs.	0.23 lbs.	0.26 lbs.	0.26 lbs.
Mar. 31, 1941	0.30 lbs.	0.30 lbs.	0.27 lbs.	0.27 lbs.	0.27 lbs.	0.27 lbs.	0.23 lbs.	0.23 lbs.	0.26 lbs.	0.26 lbs.
LOT 3—ENVIRONMENTAL TEMPERATURE—0° F. AIR MOVEMENT—0. BIRDS CONFINED IN GROUP										
Mar. 27, 1941	0.36 lbs.	0.40 lbs.	0.42 lbs.	0.38 lbs.	0.41 lbs.	0.31 lbs.	0.36 lbs.	0.36 lbs.	0.36 lbs.	0.34 lbs.
Mar. 28, 1941	0.33 lbs.	0.37 lbs.	0.39 lbs.	0.35 lbs.	0.37 lbs.	0.28 lbs.	0.34 lbs.	0.32 lbs.	0.34 lbs.	0.30 lbs.
Mar. 29, 1941	0.30 lbs.	0.34 lbs.	0.36 lbs.	0.32 lbs.	0.35 lbs.	0.25 lbs.	0.32 lbs.	0.29 lbs.	0.30 lbs.	0.28 lbs.
Mar. 30, 1941	0.27 lbs.	0.31 lbs.	0.33 lbs.	0.28 lbs.	0.32 lbs.	0.24 lbs.	0.30 lbs.	0.25 lbs.	0.26 lbs.	0.26 lbs.
Mar. 31, 1941	0.24 lbs.	0.27 lbs.	0.30 lbs.	0.27 lbs.	0.30 lbs.	0.24 lbs.	0.28 lbs.	0.24 lbs.	0.24 lbs.	0.23 lbs.
Apr. 1, 1941	0.23 lbs.	0.26 lbs.	0.28 lbs.	0.27 lbs.	0.26 lbs.	0.26 lbs.	0.26 lbs.	0.24 lbs.	0.24 lbs.	0.23 lbs.
LOT 4—ENVIRONMENTAL TEMPERATURES—36°-44° F. AIR MOVEMENT—0. BIRDS INDIVIDUALLY CONFINED										
Mar. 27, 1941	0.34 lbs.	0.36 lbs.	0.40 lbs.	0.38 lbs.	0.38 lbs.	0.35 lbs.	0.34 lbs.	0.35 lbs.	0.35 lbs.	0.35 lbs.
Mar. 28, 1941	0.31 lbs.	0.33 lbs.	0.37 lbs.	0.35 lbs.	0.37 lbs.	0.33 lbs.	0.32 lbs.	0.32 lbs.	0.32 lbs.	0.32 lbs.
Mar. 29, 1941	0.30 lbs.	0.30 lbs.	0.33 lbs.	0.32 lbs.	0.34 lbs.	0.29 lbs.	0.29 lbs.	0.29 lbs.	0.29 lbs.	0.29 lbs.
Mar. 30, 1941	0.29 lbs.	0.29 lbs.	0.31 lbs.	0.28 lbs.	0.31 lbs.	0.25 lbs.	0.25 lbs.	0.25 lbs.	0.25 lbs.	0.25 lbs.
Mar. 31, 1941	0.27 lbs.	0.27 lbs.	0.27 lbs.	0.26 lbs.	0.27 lbs.	0.22 lbs.	0.22 lbs.	0.22 lbs.	0.22 lbs.	0.21 lbs.
Apr. 1, 1941	0.23 lbs.	0.23 lbs.	0.23 lbs.	0.23 lbs.	0.23 lbs.	0.22 lbs.	0.22 lbs.	0.22 lbs.	0.22 lbs.	0.21 lbs.

General Notes: All birds without food or water at all times.
Experiment inaugurated at 4:00 P. M. Daily weights are as recorded at that time unless otherwise noted.
Percentages of initial body weights lost up to time of death or removal from the chamber: Lot 1—No. 1—20.6%, No. 2—18.9%, No. 3—18.4%, No. 4—15.8%, No. 5—14.3%, No. 6—11.9%, No. 7—26.4%, No. 8—11.4%, No. 9—18.4%, No. 10—12.2%, Lot 2—No. 1—30.2%, No. 2—31.0%, No. 3—27.0%, No. 4—17.6%, No. 5—25.0%, No. 6—7.9%, No. 7—26.3%, No. 8—31.5%, No. 9—10.3%, No. 10—25.7%, Lot 3—No. 1—33.4%, No. 2—33.3%, No. 3—33.3%, No. 4—28.9%, No. 5—23.9%, No. 6—36.6%, No. 7—22.6%, No. 8—27.8%, No. 9—27.8%, No. 10—32.4%, Lot 4—No. 1—35.3%, No. 2—22.3%, No. 3—32.5%, No. 4—31.6%, No. 5—28.9%, No. 6—28.6%, No. 7—35.3%, No. 8—40.0%.

A—Extra records at 10:30 A. M.
B—Extra records at 8:00 A. M.
C—Extra records at 11:00 A. M.
D—Indicates dead bird.
E—Extra records at 11:00 A. M.
F—Extra records at 8:00 A. M.
G—Extra records at 11:00 A. M.
R—Bird removed alive, but died shortly.

formation, exhibited survival periods ranging from a little less than three to almost four and three-quarters days (65 to 114 hours), with an average of 4.1 days (98 hours). These birds succumbed at points ranging from 63.4% to 77.4% of their initial weights, while the group figure was 68.1% of the total starting weight. The eight control birds subject to the "standard" conditions lived from less than three to over five and one-half days (65 to 136 hours), with an average of 3.9 days (92 hours). The maximum weight loss was 40.0%, the minimum 22.3%, and the aggregate 31.8%.

TABLE VII
FASTING EXPERIMENT—RUFFED GROUSE
(*Bonasa umbellus umbellus*)

Type Stock: Artificially propagated, various ages.

Dates	Env. Temp.—0° F. A. Mov.—5.8 M.P.H.		Env. Temp.—0° F. A. Mov.—0		Env. Temp.—37°-50° F. A. Mov.—0	
	B. Wt. No. 1 F	B. Wt. No. 2 M	B. Wt. No. 3 F	B. Wt. No. 4 M	B. Wt. No. 5 F	B. Wt. No. 6 M
Feb. 29, 1940--	1.17 lbs.	1.62 lbs.	1.32 lbs.	1.39 lbs.	1.28 lbs.	1.22 lbs.
Mar. 1, 1940--	1.13 lbs.	1.60 lbs.	1.28 lbs.	1.36 lbs.	1.24 lbs.	1.17 lbs.
Mar. 2, 1940--	1.05 lbs. D	1.54 lbs.	1.25 lbs.	1.30 lbs.	1.20 lbs.	1.06 lbs.
Mar. 3, 1940--		1.47 lbs.	1.21 lbs.	1.23 lbs.	1.13 lbs.	.93 lbs.
Mar. 4, 1940--		1.40 lbs.	1.17 lbs.	1.15 lbs.	1.07 lbs.	.89 lbs. D
Mar. 5, 1940--		1.36 lbs.	1.13 lbs.	1.06 lbs. D	1.00 lbs.	
Mar. 6, 1940--		1.33 lbs.	1.10 lbs.		.95 lbs.	
Mar. 7, 1940--		1.27 lbs.	1.04 lbs.		.91 lbs.	
Mar. 8, 1940--		1.25 lbs.	1.00 lbs.		.87 lbs.	
Mar. 9, 1940--		1.17 lbs.	.91 lbs.		.84 lbs.	
Mar. 10, 1940--		1.06 lbs.	.80 lbs. D		.82 lbs. D	
Mar. 11, 1940--		1.03 lbs. D				

Notes: All birds without food or water at all times.

D—Indicates dead bird.

Percentages of initial body weights lost up to time of death: No. 1—11.3%, No. 2—36.4%, No. 3—39.4%, No. 4—23.8%, No. 5—35.9%, No. 6—27.1%.

The data above discussed tend to emphasize two highly important points. First, it is obvious that compared to various other game species, such as the pheasant and the turkey, the bobwhite is relatively weak in its power to withstand environmental hardships, including both food shortages and exposure. Second, the effect of covey size on ability to survive periods of winter stress is clearly exemplified.

Ruffed Grouse—Six ruffed grouse (*Bonasa umbellus umbellus*), all artificially propagated birds of various ages, were available for use in the fasting series. Table VII, page 44, summarizes the results of a laboratory experiment in which they were used.

One pair of birds was held at 0°F. with a constant "wind" of 5.8 miles per hour without food or water. The female died toward the close of the second day of experimentation (about 42 hours) at 88.7% of its initial weight. The male lived almost eleven days (roughly 260 hours), exhibiting a weight loss of 36.4%. Thus, the average period of survival was between six and seven days (150 hours) and the aggregate weight loss 25.4%. Two additional birds without food or water were kept at zero with no air movement. The hen succumbed in less than 11 and the cock toward the end of the fifth day (approximately 260 and 115 hours). Thus, the average time of survival was short of eight days (roughly 185 hours). The individual weight losses were 39.4% and 23.8%, respectively, while that for the pair was 31.4%. The remaining birds were fasted under the "standard" laboratory conditions. One lived just short of 10 days, the other not quite five days (235 and 115 hours). Again, therefore, the average was between seven and eight days (roughly 180 hours). The loss of weight exhibited by the female was 35.9% and by the male 27.1%. Their collective drop was 31.6%.

Though not conclusive because of both the number and type of birds utilized, the statistics gathered from the test indicate that the grouse is a comparatively vigorous species. Furthermore, since they are in nature seldom exposed to extremely severe conditions, due to their habits of "budding" and diving into the snow to roost, it is obvious that winter hardships cannot frequently be expected to cause the birds serious suffering.

Hungarian Partridge—The Hungarian, or grey partridge (*Perdix perdix perdix*), was also tested to determine its fasting powers under laboratory conditions. Three pairs of artificially propagated birds approximately nine months of age were used in the work undertaken in late March and early April of 1940. The statistics gathered are to be found in Table VIII, page 46.

Once again one pair of birds was fasted at 0°F. with a constant air movement of 5.8 miles per hour; a second, at 0° with on wind; and a third, under "standard" conditions. Of the first two, one perished on the fifth and the other on the sixth day (roughly 115 and 140 hours). Their losses in body weight were 40.6% and 39.8%, respectively. As a group, therefore, their average period of survival was approximately five and one-half days (130 hours) and their aggregate weight loss 40.1%. The second duo survived almost six and nearly eight days (140 and 185 hours). The hen died at 63.2% of its starting weight and the cock at

TABLE VIII
FASTING EXPERIMENT—HUNGARIAN PARTRIDGE
(*Perdix perdix perdix*)

Type Stock: Artificially propagated, approximately 9 months of age.

Dates	Env. Temp.—0° F. Air Mov.—5.8 M.P.H.				Env. Temp.—0° F. Air Mov.—0				Env. Temp.—34° to 49° F. Air Mov.—0			
	Body Weights		Body Temps.		Body Weights		Body Temps.		Body Weights		Body Temps.	
	No. 1 F	No. 2 M	No. 1 F	No. 2 M	No. 3 F	No. 4 M	No. 3 F	No. 4 M	No. 5 F	No. 6 M	No. 5 F	No. 6 M
March 18, 1940	.69 lbs.	.83 lbs.	109.3° F.	109.0° F.	.68 lbs.	.85 lbs.	109.2° F.	109.4° F.	.76 lbs.	.90 lbs.	109.8° F.	109.1° F.
March 19, 1940	.62 lbs.	.76 lbs.	106.4° F.	106.8° F.	.62 lbs.	.82 lbs.	108.3° F.	108.1° F.	.68 lbs.	.84 lbs.	108.2° F.	108.3° F.
March 20, 1940	.58 lbs.	.70 lbs.	107.3° F.	106.3° F.	.59 lbs.	.78 lbs.	106.9° F.	108.1° F.	.66 lbs.	.	107.7° F.	108.4° F.
March 21, 1940	.53 lbs.	.65 lbs.	107.0° F.	106.1° F.	.56 lbs.	.74 lbs.	108.1° F.	107.2° F.	.64 lbs.	.78 lbs.	108.6° F.	109.0° F.
March 22, 1940	.45 lbs.	.61 lbs.	105.8° F.	106.6° F.	.53 lbs.	.71 lbs.	107.5° F.	107.4° F.	.63 lbs.	.76 lbs.	109.2° F.	109.4° F.
March 23, 1940	.41 lbs. D	.50 lbs.		100.2° F.	.48 lbs.	.63 lbs.	107.4° F.	106.7° F.	.60 lbs.	.73 lbs.	108.0° F.	108.5° F.
March 24, 1940		.50 lbs. D			.43 lbs. D	.61 lbs.	106.8° F.	107.0° F.	.59 lbs.	.73 lbs.	107.3° F.	108.2° F.
March 25, 1940						.54 lbs.		105.4° F.	.55 lbs.	.71 lbs.	107.2° F.	108.8° F.
March 26, 1940						.49 lbs. D			.50 lbs.	.69 lbs.	106.0° F.	107.8° F.
March 27, 1940									.45 lbs.	.67 lbs.	105.0° F.	107.5° F.
March 28, 1940									.39 lbs. D	.65 lbs.		106.7° F.
March 29, 1940										.63 lbs.		106.6° F.
March 30, 1940										.61 lbs.		107.3° F.
March 31, 1940										.58 lbs.		108.0° F.
April 1, 1940										.53 lbs.		106.2° F.
April 2, 1940										.46 lbs. D		105.4° F.

Notes: All birds without food or water at all times.

All temperatures taken in gizzard about 9:00 A. M. daily.

D—Indicates dead bird.

Percentages of initial body weights lost up to time of death: No. 1—40.6%, No. 2—39.8%, No. 3—36.8%, No. 4—42.4%, No. 5—48.7%, No. 6—48.9%.

57.6%. Thus, the average period of fast was seven days (168 hours) and the collective weight loss 39.9%. The third pair died toward the ends of the tenth and fifteenth days (roughly 235 and 355 hours), or at an average of 12.5 days (about 300 hours). The weight loss for the pair was 48.8%, while the individual figures were 48.7% and 48.9%.

In this instance, figures on daily body temperatures, taken in the gizzard with specially constructed mercurial thermometers, are also listed. At the outset, all the partridges exhibited temperatures in excess of 109.0°F. The important point is that until those few hours immediately preceding death, when the body temperature may fall below 65°F., but when recovery is still possible under favorable conditions, there is a drop of less than 10 degrees in body temperature, though fasting may have been in progress for over two weeks.

This experiment places the Hungarian partridge in a medium position with reference to ability to survive winter cold without benefit of food. Far more enduring than the quail, its fasting powers do not approach those of the pheasant. Its highly successful introduction into the Canadian wheat belt would seem, however, to indicate unusually high resistance to exposure.

Chukar Partridge—The chukar partridge (*Alectoris graeca* sp.) is an exotic species which has been widely experimented within the United States and Canada during the past few years. Apparently, however, with few exceptions, the introductions have proven entirely unsuccessful. Six artificially propagated birds of this species, including four females and two males all approximately nine months of age, were subjected to forced fasts under varied conditions. Two hens were held at 0°F. with a constant air flow of 5.8 miles per hour; a cock and a hen were confined at the same temperature with no air movement; while a second pair of partridges were tested under the "standard" conditions previously discussed. The recorded data are summarized in Table IX, page 48.

Examination of the figures shows that though one of the birds was accidentally killed at the end of one week's fasting, when otherwise in apparently good condition, the two females exposed to the "wind" at zero survived seven and nine days (168 and 216 hours), with an average eight days (192 hours). The former lost 24.6% of its initial body weight, the latter 40.6%, or an average of 32.9%. The pair of birds at zero with "no wind" survived on the average just over 11 days (270 hours), one perishing in a little less than 10 days (235 hours), the other after 12-1/3 days (296 hours). The first died at 56.6% of its starting weight, the other at slightly less, or 56.3%. The average loss in weight was 43.5%.

The first control bird died at the end of two weeks (336 hours), exhibiting a loss of 56.3% in body weight, while the second lived nearly

TABLE IX
FASTING EXPERIMENT—CHUKAR PARTRIDGE
(*Alectoris gracca* sp.)

Type Stock: Artificially propagated, approximately 9 months of age.

Dates	Env. Temp.—0° F. Air Mov.—5.8 M.P.H.				Env. Temp.—0° F. Air Mov.—0				Env. Temp.—34° to 50° F. Air Mov.—0			
	Body Weights		Body Temps.		Body Weights		Body Temps.		Body Weights		Body Temps.	
	No. 1 F	No. 2 F	No. 1 F	No. 2 F	No. 3 M	No. 4 F	No. 3 M	No. 4 F	No. 5 M	No. 6 F	No. 5 M	No. 6 F
March 2, 1940	1.18 lbs.	1.23 lbs.	107.3° F.	109.1° F.	1.50 lbs.	1.20 lbs.	1.20 lbs.	108.2° F.	1.42 lbs.	1.33 lbs.	107.6° F.	108.4° F.
March 3, 1940	1.14 lbs.	1.22 lbs.	107.2° F.	108.2° F.	1.43 lbs.	1.21 lbs.	1.21 lbs.	108.0° F.	1.34 lbs.	1.33 lbs.	108.0° F.	107.5° F.
March 4, 1940	1.10 lbs.	1.18 lbs.	106.0° F.	107.1° F.	1.33 lbs.	1.17 lbs.	1.17 lbs.	108.0° F.	1.29 lbs.	1.29 lbs.	108.4° F.	108.3° F.
March 5, 1940	1.05 lbs.	1.13 lbs.	107.0° F.	107.6° F.	1.33 lbs.	1.13 lbs.	1.13 lbs.	108.0° F.	1.23 lbs.	1.27 lbs.	108.9° F.	108.5° F.
March 6, 1940	1.00 lbs.	1.09 lbs.	108.5° F.	109.3° F.	1.28 lbs.	1.09 lbs.	1.09 lbs.	108.9° F.	1.22 lbs.	1.21 lbs.	109.2° F.	108.5° F.
March 7, 1940	.94 lbs.	1.02 lbs.	108.4° F.	108.7° F.	1.22 lbs.	1.04 lbs.	1.04 lbs.	109.3° F.	1.20 lbs.	1.18 lbs.	108.2° F.	109.0° F.
March 8, 1940	.93 lbs.	.98 lbs.	108.3° F.	108.2° F.	1.18 lbs.	1.02 lbs.	1.02 lbs.	109.2° F.	1.16 lbs.	1.16 lbs.	109.3° F.	108.9° F.
March 9, 1940	.89 lbs. A	.93 lbs.	108.3° F.	108.8° F.	1.14 lbs.	.99 lbs.	.99 lbs.	109.1° F.	1.13 lbs.	1.13 lbs.	108.7° F.	108.4° F.
March 10, 1940		.85 lbs.		107.8° F.	1.08 lbs.	.96 lbs.	.96 lbs.	108.0° F.	1.10 lbs.	1.11 lbs.	108.6° F.	108.3° F.
March 11, 1940		.76 lbs. D			.95 lbs.	.92 lbs.	.92 lbs.	105.6° F.	1.06 lbs.	1.08 lbs.	108.3° F.	108.4° F.
March 12, 1940					.85 lbs. D	.89 lbs.	.89 lbs.		.99 lbs.	1.04 lbs.	107.3° F.	107.2° F.
March 13, 1940						.83 lbs.	.83 lbs.		.91 lbs.	.99 lbs.	104.2° F.	104.9° F.
March 14, 1940						.73 lbs.	.73 lbs.		.78 lbs.	.89 lbs.	105.2° F.	102.0° F.
March 15, 1940						.71 lbs. DE			.67 lbs.	.82 lbs. D	105.0° F.	
March 16, 1940									.62 lbs. D			

Notes: All birds without food or water at all times.

All body temperature readings taken in gizzard about noon.

A—Bird died of broken artery punctured in taking temperature.

D—Indicates dead bird.

E—Bird actually died 4:00 P. M., March 14.

Percentages of initial body weights lost up to time of death: No. 1—24.6%, No. 2—40.6%, No. 3—43.4%, No. 4—43.7%, No. 5—56.3%, No. 6—41.0%.

13 days (310 hours) after losing only 41.0% of its initial weight. Thus, the average period of survival was 13-1/2 days (348 hours) and the average weight loss 47.8%.

The body temperature figures listed in the table show also for this species that there is no appreciable drop in body heat until the last few hours immediately preceding death.

Particularly when it is realized that the average loss in body weight of all six specimens equaled only 22.7% at the end of the first week's fasting, it is obvious that, as far as its ability to withstand cold and hunger is concerned, the chukar is a relatively hardy species.

Mallard Duck—The only species of waterfowl utilized in the fasting experiments was the mallard duck (*Anas platyrhynchos platyrhynchos*). A total of 22 semi-domesticated, artificially propagated birds of unknown ages was fasted under laboratory conditions.

Four pairs of birds were held at 0° F. with a constant "wind" of 5.8 miles per hour without food or water. A like number was held under the same conditions except for the fact that they were subject to no movement of air. The remaining six birds, including three of each sex, were tested under the "standard" conditions previously described. The resulting data are to be found in Table X, page 50.

The lot of birds at zero "in the wind" survived from a minimum of not quite one week (160 hours) to a maximum of two full weeks (336 hours), with an average of 11.9 days (roughly 285 hours). In this group as in all others, the birds were removed from the chamber only when obviously on the point of death. In such instances, they were usually only semi-conscious with body temperatures 40 or more degrees (F.) below normal. The minimum, maximum and aggregate weight losses were 27.3%, 41.7% and 35.6%, respectively. Those eight ducks at zero with no air movement lived a minimum of just under five days (115 hours), a maximum of 16 full days (384 hours) and an average of 9.4 days (225 hours). The collective loss in body weight was 33.9%, with a maximum individual drop of 46.4% and minimum of 20.1%. Under the "standard" conditions, the minimum, maximum and average survival periods were, respectively, six, 24 and 11.5 days (144, 576 and 276 hours). In this group the aggregate loss in body weight was also 33.9%, with an individual high of 46.5% and a corresponding low of 22.4%.

As will later be discussed, the figures for the mallard are in certain respects at variance with those for all other species worked with, but they nonetheless indicate clearly that the bird is one which can doubtless endure without difficulty a week or ten days of low temperature and limited food supplies.

Great Horned Owl—Experiments involving two species of birds belonging to that group commonly referred to as avian predators were

TABLE X
FASTING EXPERIMENT—MALLARD DUCK
(*Anas platyrhynchos platyrhynchos*)
Type Stock: Semi-domesticated, artificially propagated, various ages.

Dates	Environmental Temperature—0° F. Air Movement—5.8 M.P.H.							
	B. Wght. No. 1 M	B. Wght. No. 2 M	B. Wght. No. 3 M	B. Wght. No. 4 F	B. Wght. No. 5 F	B. Wght. No. 6 F	B. Wght. No. 7 F	B. Wght. No. 8 M
March 26, 1941	2.53 lbs.	2.37 lbs.	2.66 lbs.	2.50 lbs.	2.66 lbs.	2.46 lbs.	2.49 lbs.	2.74 lbs.
March 27, 1941	2.35 lbs.	2.23 lbs.	2.52 lbs.	2.37 lbs.	2.50 lbs.	2.34 lbs.	2.37 lbs.	2.57 lbs.
March 28, 1941	2.18 lbs.	2.13 lbs.	2.44 lbs.	2.28 lbs.	2.42 lbs.	2.27 lbs.	2.26 lbs.	2.48 lbs.
March 29, 1941	2.09 lbs.	2.06 lbs.	2.37 lbs.	2.21 lbs.	2.30 lbs.	2.20 lbs.	2.19 lbs.	2.39 lbs.
March 30, 1941	2.02 lbs.	1.99 lbs.	2.30 lbs.	2.15 lbs.	2.24 lbs.	2.15 lbs.	2.12 lbs.	2.33 lbs.
March 31, 1941	1.94 lbs.	1.94 lbs.	2.25 lbs.	2.09 lbs.	2.19 lbs.	2.10 lbs.	2.06 lbs.	2.26 lbs.
April 1, 1941	1.88 lbs.	1.85 lbs.	2.18 lbs.	2.04 lbs.	2.12 lbs.	2.04 lbs.	2.00 lbs.	2.21 lbs.
April 2, 1941	1.84 lbs. D	1.77 lbs.	2.10 lbs.	2.00 lbs.	2.07 lbs.	1.99 lbs.	1.95 lbs.	2.16 lbs.
April 3, 1941		1.64 lbs.	2.03 lbs.	1.93 lbs.	1.97 lbs.	1.91 lbs.	1.88 lbs.	2.09 lbs.
April 4, 1941		1.49 lbs. R	1.92 lbs.	1.87 lbs.	1.88 lbs.	1.84 lbs.	1.84 lbs.	2.04 lbs.
April 5, 1941			1.81 lbs. R	1.81 lbs.	1.75 lbs.	1.78 lbs.	1.76 lbs.	1.99 lbs.
April 6, 1941				1.70 lbs. R	1.62 lbs. R	1.69 lbs.	1.66 lbs.	1.91 lbs.
April 7, 1941						1.60 lbs. R	1.54 lbs.	1.83 lbs.
April 8, 1941							1.48 lbs. R	1.71 lbs.
April 9, 1941								1.60 lbs. R

Dates	Environmental Temperature—0° F. Air Movement—0							
	B. Wght. No. 9 M	B. Wght. No. 10 F	B. Wght. No. 11 M	B. Wght. No. 12 F	B. Wght. No. 13 M	B. Wght. No. 14 M	B. Wght. No. 15 F	B. Wght. No. 16 F
March 26, 1941	1.88 lbs.	2.04 lbs.	2.07 lbs.	2.20 lbs.	2.50 lbs.	2.59 lbs.	2.38 lbs.	2.37 lbs.
March 27, 1941	1.73 lbs.	1.93 lbs.	1.93 lbs.	2.05 lbs.	2.29 lbs.	2.41 lbs.	2.24 lbs.	2.19 lbs.
March 28, 1941	1.63 lbs.	1.84 lbs.	1.83 lbs.	1.98 lbs.	2.17 lbs.	2.32 lbs.	2.15 lbs.	2.10 lbs.
March 29, 1941	1.56 lbs.	1.77 lbs.	1.77 lbs.	1.92 lbs.	2.03 lbs.	2.24 lbs.	2.09 lbs.	2.03 lbs.
March 30, 1941	1.49 lbs.	1.70 lbs.	1.70 lbs.	1.86 lbs.	2.00 lbs.	2.17 lbs.	2.02 lbs.	1.97 lbs.
March 31, 1941	1.44 lbs. D	1.63 lbs. R	1.63 lbs.	1.80 lbs.	1.94 lbs.	2.11 lbs.	1.96 lbs.	1.91 lbs.
April 1, 1941			1.57 lbs.	1.74 lbs.	1.88 lbs.	2.06 lbs.	1.91 lbs.	1.86 lbs.
April 2, 1941			1.50 lbs. R	1.70 lbs.	1.83 lbs.	2.01 lbs.	1.85 lbs.	1.81 lbs.
April 3, 1941				1.62 lbs.	1.76 lbs.	1.94 lbs.	1.79 lbs.	1.75 lbs.
April 4, 1941				1.56 lbs. R	1.69 lbs.	1.86 lbs.	1.73 lbs.	1.70 lbs.
April 5, 1941					1.60 lbs. R	1.79 lbs.	1.67 lbs.	1.65 lbs.
April 6, 1941						1.66 lbs.	1.58 lbs.	1.60 lbs.
April 7, 1941						1.50 lbs. R	1.48 lbs.	1.56 lbs.
April 8, 1941							1.42 lbs. D	1.49 lbs.
April 9, 1941								1.43 lbs.
April 10, 1941								1.33 lbs.
April 11, 1941								1.27 lbs. R

Dates	Environmental Temperature—36° to 46° F. Air Movement—0					
	B. Wght. No. 17 M	B. Wght. No. 18 M	B. Wght. No. 19 F	B. Wght. No. 20 F	B. Wght. No. 21 M	B. Wght. No. 22 F
March 26, 1941	2.37 lbs.	1.96 lbs.	2.23 lbs.	2.04 lbs.	2.71 lbs.	3.01 lbs.
March 27, 1941	2.23 lbs.	1.79 lbs.	2.07 lbs.	1.91 lbs.	2.50 lbs.	2.81 lbs.
March 28, 1941	2.09 lbs.	1.70 lbs.	1.98 lbs.	1.82 lbs.	2.40 lbs.	2.72 lbs.
March 29, 1941	2.02 lbs.	1.64 lbs.	1.93 lbs.	1.74 lbs.	2.30 lbs.	2.64 lbs.
March 30, 1941	1.96 lbs.	1.56 lbs.	1.87 lbs.	1.69 lbs.	2.21 lbs.	2.57 lbs.
March 31, 1941	1.90 lbs.	1.49 lbs.	1.82 lbs.	1.63 lbs.	2.14 lbs.	2.51 lbs.
April 1, 1941	1.84 lbs. D	1.47 lbs. D	1.77 lbs.	1.58 lbs.	2.07 lbs.	2.44 lbs.
April 2, 1941			1.72 lbs.	1.54 lbs.	2.01 lbs.	2.39 lbs.
April 3, 1941			1.67 lbs.	1.47 lbs.	1.93 lbs.	2.33 lbs.
April 4, 1941			1.66 lbs. D	1.42 lbs. D	1.88 lbs.	2.27 lbs.
April 5, 1941					1.82 lbs.	2.22 lbs.
April 6, 1941					1.76 lbs.	2.18 lbs.
April 7, 1941					1.70 lbs.	2.13 lbs.
April 8, 1941					1.63 lbs.	2.07 lbs.
April 9, 1941					1.56 lbs.	2.03 lbs.
April 10, 1941					1.46 lbs. D	1.99 lbs.
April 11, 1941						1.95 lbs.
April 12, 1941						1.90 lbs.
April 13, 1941						1.86 lbs.
April 14, 1941						1.83 lbs.
April 15, 1941						1.78 lbs.
April 16, 1941						1.74 lbs.
April 17, 1941						1.70 lbs.
April 18, 1941						1.65 lbs.
April 19, 1941						1.61 lbs. R

Notes: All birds without food or water at all times.
D—Indicates dead bird.
R—Indicates bird removed from chamber at point of death and later (if surviving) used in fecundity test.
Percentages of initial body weight lost up to time of death or removal from the chamber: No. 1—27.3%, No. 2—31.1%, No. 3—32.0%, No. 4—32.0%, No. 5—39.1%, No. 6—35.0%, No. 7—40.6%, No. 8—41.7%, No. 9—23.5%, No. 10—20.1%, No. 11—27.5%, No. 12—29.1%, No. 13—36.0%, No. 14—42.1%, No. 15—40.4%, No. 16—46.4%, No. 17—22.4%, No. 18—25.0%, No. 19—25.6%, No. 20—30.4%, No. 21—46.1%, No. 22—46.5%.

TABLE XI
FASTING EXPERIMENTS—GREAT HORNED OWL
(*Bubo virginianus virginianus*)
Type Stock: Wild caught, unknown ages.

Dates	Environmental Temperature—0° F. Air Movement—1.1 M.P.H.						Env. Temp.—34° to 50° F. Air Mov.—0	
	B. Wt. F	B. Wt. F	B. Wt. F	B. Wt. F	B. Wt. F	B. Wt. F	B. Wt. F	B. Wt. F
January 24, 1940	2.94 lbs.	3.70 lbs.	4.10 lbs.	4.37 lbs.	3.95 lbs.	3.73 lbs.	March 1, 1940	3.73 lbs.
January 25, 1940	2.84 lbs.	3.56 lbs.	3.95 lbs.	3.98 lbs.	3.80 lbs.	3.63 lbs.	March 2, 1940	3.63 lbs.
January 26, 1940	2.70 lbs.	3.46 lbs.	3.86 lbs.	3.87 lbs.	3.69 lbs.	3.53 lbs.	March 3, 1940	3.53 lbs.
January 27, 1940	2.59 lbs. AD	3.38 lbs.	3.78 lbs.	3.76 lbs.	3.61 lbs.	3.45 lbs.	March 4, 1940	3.45 lbs.
January 28, 1940		3.30 lbs.	3.71 lbs.	3.70 lbs.	3.54 lbs.	3.42 lbs.	March 5, 1940	3.42 lbs.
January 29, 1940		3.23 lbs.	3.62 lbs.	3.63 lbs.	3.49 lbs.	3.32 lbs.	March 6, 1940	3.32 lbs.
January 30, 1940		3.20 lbs.	3.56 lbs.	3.56 lbs.	3.45 lbs.	3.24 lbs.	March 7, 1940	3.24 lbs.
January 31, 1940		3.11 lbs.	3.48 lbs.	3.50 lbs.	3.38 lbs.	3.19 lbs.	March 8, 1940	3.19 lbs.
February 1, 1940		3.03 lbs.	3.39 lbs.	3.44 lbs.	3.31 lbs.	3.13 lbs.	March 9, 1940	3.13 lbs.
February 2, 1940		2.87 lbs.	3.23 lbs.	3.36 lbs.	3.27 lbs.	2.95 lbs.	March 10, 1940	2.95 lbs.
February 3, 1940		2.73 lbs.	3.09 lbs.	3.29 lbs.	3.23 lbs.	2.84 lbs.	March 11, 1940	2.84 lbs.
February 4, 1940		2.76 lbs.	2.89 lbs.	3.19 lbs.	3.19 lbs.	2.78 lbs.	March 12, 1940	2.78 lbs.
February 5, 1940		2.62 lbs. D	2.85 lbs. D	3.02 lbs.	3.13 lbs.	2.68 lbs. D	March 13, 1940	2.68 lbs. D
February 6, 1940				2.99 lbs. D	3.06 lbs.		March 14, 1940	
February 7, 1940					2.94 lbs.			
February 8, 1940					2.86 lbs.			
February 9, 1940					2.71 lbs. R			
February 10, 1940								

Notes: All birds without food or water at all times.
A—Recently caught. Death believed to be chiefly result of trap injury.
D—Indicates dead bird.
R—Bird removed from chamber alive. Exhibited complete recovery.
Percentages of initial body weights lost up to time of death or removal from chamber: No. 1—11.9%, No. 2—33.0%, No. 3—29.2%, No. 4—30.5%, No. 5—31.6%, No. 6—31.4%, No. 7—27.9%.

included in the series under consideration. One of these was the great horned owl (*Bubo virginianus virginianus*). A total of seven individuals, all females, was subjected to forced fasts. Six wild trapped specimens of unknown ages were simultaneously tested at 0°F. with a constant "wind" of 1.1 miles per hour, while the seventh, caught at a later date, was fatally fasted under the "standard" conditions. The data obtained are summarized in Table XI, page 51.

Examination of the statistics will reveal the fact that, with the exception of an injured individual in poor flesh which perished in less than 72 hours, the experimental birds confined in individual cages at 0°F. survived from a minimum of almost 11 days (approximately 255 hours) to a maximum of over 17 days (408 hours) with an average of 12.8 days (roughly 305 hours). The percentages of body weight lost ranged from a low of 29.2% to a high of 33.0%, averaging 31.2%. In this test, it must be remembered that one individual survived, and later fully recovered from, a fast of 17 days (408 hours).

The control animal lived for just less than 13 days (310 hours), losing 27.9% of its initial weight during the experiment. The differences noted between the experimentals and the check bird doubtless are accounted for by the fact that only one individual was available for comparative purposes.

From the evidence gained, it would appear that members of this species can readily survive totally without food for a full week of severe winter weather, suffering no serious ill-effects therefrom. Activity in the wild would doubtless result in greater weight losses than were revealed in the experiment, an average of 16.3% for the 5 normal owls held at zero and 14.5% in the case of the control bird, but they could hardly be expected to approach lethal limits within a seven-day period.

Red-Shouldered Hawk—The second species of avian predator experimented with was the red-shouldered hawk (*Buteo lineatus lineatus*). Of three wild caught females, two of which were captive-reared young, a mature individual was fasted at 0°F. with a constant "wind" of 5.8 miles per hour, one immature bird was confined at 0°F. with no air movement, while the second young specimen was subjected to the "standard" winter conditions. The resulting statistics are presented in Table XII, page 53.

As indicated in the table, there was appreciable difference between the survival time of the two experimental hawks, that facing the high "wind" living less than six days (roughly 140 hours) and the other succumbing in about 11.5 days (260 hours). Particularly since the individual "out of the wind" survived so much longer than the older bird in the "wind," appreciable importance must here again be attached to air movement as a factor in survival under stress. Furthermore, in the light

of the owl experiment previously discussed, the fact the second experimental and the check bird died at almost exactly the same time would seem possible to indicate that at least in the lower ranges, environmental

TABLE XII
FASTING EXPERIMENT—RED-SHOULDERED HAWK
(*Buteo lineatus lineatus*)
Type Stock: Wild-trapped, various ages.

Dates	Env. Temp. 0° F.		Env. Temp. 34°-50° F.
	Air Mov.—5.8 M P.H.	Air Mov.—0	Air Mov.—0
	B. Wt. No. 1 Mat. F	B. Wt. No. 2 Imm. F	B. Wt. No. 3 Imm. F
March 2, 1940 -----	1.57 lbs. A	1.89 lbs. B	1.46 lbs. C
March 3, 1940 -----	1.47 lbs.	1.77 lbs.	1.43 lbs.
March 4, 1940 -----	1.41 lbs.	1.70 lbs.	1.38 lbs.
March 5, 1940 -----	1.36 lbs.	1.64 lbs.	1.32 lbs.
March 6, 1940 -----	1.31 lbs.	1.61 lbs.	1.28 lbs.
March 7, 1940 -----	1.23 lbs.	1.52 lbs.	1.26 lbs.
March 8, 1940 -----	1.20 lbs. D	1.48 lbs.	1.23 lbs.
March 9, 1940 -----		1.42 lbs. E	1.19 lbs.
March 10, 1940 -----		1.37 lbs.	1.19 lbs.
March 11, 1940 -----		1.34 lbs.	1.17 lbs.
March 12, 1940 -----		1.27 lbs.	1.13 lbs. G
March 13, 1940 -----		1.19 lbs.	1.12 lbs. H
March 13, 1940 F -----		1.13 lbs. D	1.03 lbs. D

Notes: All birds without food or water at all times.

A—Rectal temperature—108.0° F. (noon).

B—Rectal temperature—106.4° F., stomach temperature—107.5° F. (noon).

C—Rectal temperature—107.0° F. (noon).

D—Indicates dead bird.

E—Injury to wing with appreciable blood loss.

F—Record at 8:00 P. M.

G—Rectal temperature—99.4° F. (noon).

H—Rectal temperature—97.5° F. (3:00 P. M.).

Percentages of initial body weights lost up to time of death: No. 1—23.6%, No. 2—40.3%, No. 3—29.5%.

temperature has comparatively small effect on the ability of the larger hawks and owls to survive climatic extremes.

Considering the fact that specimens numbers 2 and 3 had, on the average, lost under the conditions provided only slightly more than 22% of their initial body weights at the end of the first seven days without food or water, it would seem probable that, like the great horned owl, this species too can survive in the wild a full week of winter fasting without dire consequences.



Figure 10. Undernourished deer at point of death.

Whitetailed Deer—Since winter deer losses have been the subject of numerous investigations, practically all of which have shown that the deaths of the animals are a result of malnutrition rather than of actual starvation, it was deemed unwise to sacrifice more than one animal for the fasting experiments. The individual used was a native Pennsylvania whitetail (*Odocoileus virginianus* sp.). About 10 months of age, it was a male specimen was born in the wild but captive reared.

At the start of the test on March 7, 1941, the animal appeared to be in excellent condition. Its weight was 75.5 pounds. It died early on the morning of March 21 at 54.0 pounds, or at 71.5% of its initial total. No

food was at any time available, though water, in the form of rain or snow, could be had at any time. The environmental temperature during the period ranged from 11° to 58°F. In this connection, it is interesting to note that in experiments conducted in New York State, a buck fed on balsam died after 28 days at 78% of its initial weight, while on a meadow hay and balsam diet, a buck and a doe each perished on the forty-first day at 69% and 76% of their respective initial weight (Maynard, Bump, Darrow and Woodward, 1935).

The information above presented clearly indicates that the deer is a relatively hardy species which succumbs to starvation, or malnutrition, only after comparatively long periods of time. In view of the fact that food of some type is invariably available to animals in the wild, death usually comes only after continued weeks of unfavorable conditions, particularly during late winter, when the days frequently are relatively warm and the nights quite cold.

Cottontail Rabbit—The only mammalian small game species included in the fasting studies was the cottontail rabbit (*Sylvilagus floridanus mallurus*)*. Of this form, seven male and seven female wild trapped specimens of unknown ages were utilized. Five of these were fasted at 0°F. with a constant "wind" of 5.8 miles per hour, five were exposed to the same temperature with no wind, while four were used as controls fasting under the "standard" conditions. The records for each particular animal are shown in Table XIII, page 56.

The animals at zero "in the wind" survived on the average one and three-quarters days (42 hours), with a minimum of less than one (20 hours) and a maximum of three and one-quarter days (about 80 hours). The minimum loss in body weight was 6.0%, the maximum 15.5% and the average 12.9%. Those rabbits at 0°F. with no air movement survived from one and one-quarter days (30 hours) to four days (96 hours), with an average of two and one-half days (60 hours). The losses in body weight ranged from a low of 5.8% to a high of 19.2%, with an average of 15.2%.

The cottontails exposed to the "standard winter weather" perished after from five (120 hours) to seven days (168 hours) of fasting, exhibiting an average survival of approximately five and three-quarters days (roughly 138 hours). The points of death ran from a minimum of 63.5% of the initial body weight to a maximum of 77.8%, with an average of 71.8%, representing an average loss of 22.8%.

The data above presented would seem to indicate that the cottontail is not a relatively hardy species, but in this case, the animal's normal

* Identification through courtesy of Dr. H. H. T. Jackson, U. S. Fish and Wildlife Service.

temperature has comparatively small effect on the ability of the larger hawks and owls to survive climatic extremes.

Considering the fact that specimens numbers 2 and 3 had, on the average, lost under the conditions provided only slightly more than 22% of their initial body weights at the end of the first seven days without food or water, it would seem probable that, like the great horned owl, this species too can survive in the wild a full week of winter fasting without dire consequences.



Figure 10. Undernourished deer at point of death.

Whitetailed Deer—Since winter deer losses have been the subject of numerous investigations, practically all of which have shown that the deaths of the animals are a result of malnutrition rather than of actual starvation, it was deemed unwise to sacrifice more than one animal for the fasting experiments. The individual used was a native Pennsylvania whitetail (*Odocoileus virginianus* sp.). About 10 months of age, it was a male specimen was born in the wild but captive reared.

At the start of the test on March 7, 1941, the animal appeared to be in excellent condition. Its weight was 75.5 pounds. It died early on the morning of March 21 at 54.0 pounds, or at 71.5% of its initial total. No

food was at any time available, though water, in the form of rain or snow, could be had at any time. The environmental temperature during the period ranged from 11° to 58°F. In this connection, it is interesting to note that in experiments conducted in New York State, a buck fed on balsam died after 28 days at 78% of its initial weight, while on a meadow hay and balsam diet, a buck and a doe each perished on the forty-first day at 69% and 76% of their respective initial weight (Maynard, Bump, Darrow and Woodward, 1935).

The information above presented clearly indicates that the deer is a relatively hardy species which succumbs to starvation, or malnutrition, only after comparatively long periods of time. In view of the fact that food of some type is invariably available to animals in the wild, death usually comes only after continued weeks of unfavorable conditions, particularly during late winter, when the days frequently are relatively warm and the nights quite cold.

Cottontail Rabbit—The only mammalian small game species included in the fasting studies was the cottontail rabbit (*Sylvilagus floridanus mollurus*)*. Of this form, seven male and seven female wild trapped specimens of unknown ages were utilized. Five of these were fasted at 0°F. with a constant "wind" of 5.8 miles per hour, five were exposed to the same temperature with no wind, while four were used as controls fasting under the "standard" conditions. The records for each particular animal are shown in Table XIII, page 56.

The animals at zero "in the wind" survived on the average one and three-quarters days (42 hours), with a minimum of less than one (20 hours) and a maximum of three and one-quarter days (about 80 hours). The minimum loss in body weight was 6.0%, the maximum 15.5% and the average 12.9%. Those rabbits at 0°F. with no air movement survived from one and one-quarter days (30 hours) to four days (96 hours), with an average of two and one-half days (60 hours). The losses in body weight ranged from a low of 5.8% to a high of 19.2%, with an average of 15.2%.

The cottontails exposed to the "standard winter weather" perished after from five (120 hours) to seven days (168 hours) of fasting, exhibiting an average survival of approximately five and three-quarters days (roughly 138 hours). The points of death ran from a minimum of 63.5% of the initial body weight to a maximum of 77.8%, with an average of 71.8%, representing an average loss of 22.8%.

The data above presented would seem to indicate that the cottontail is not a relatively hardy species, but in this case, the animal's normal

* Identification through courtesy of Dr. H. H. T. Jackson, U. S. Fish and Wildlife Service.

TABLE XIII
FASTING EXPERIMENT—COTTONTAIL RABBIT
(*Sylvilagus floridanus mallurus*)

Type Stock: Wild caught, ages unknown.

Env. Temperature—0° F. Air Mov.—5.8 M.P.H.					
Dates	B. Wt. No. 1 F	B. Wt. No. 2 F	B. Wt. No. 3 M	B. Wt. No. 4 M	B. Wt. No. 5 F
March 12, 1940 ----	1.74 lbs.	1.96 lbs.	2.65 lbs.	2.14 lbs.	2.52 lbs.
March 13, 1940 ----	1.56 lbs. D	1.88 lbs.	2.45 lbs.	2.07 lbs.	2.45 lbs.
March 14, 1940 ----		1.84 lbs. AD	2.22 lbs. D	1.89 lbs.	2.33 lbs.
March 15, 1940 ----				1.84 lbs. BD	2.13 lbs.
March 16, 1940 ----					2.13 lbs. CD

Env. Temperature—0° F. Air Movement—0					
Dates	B. Wt. No. 6 F	B. Wt. No. 7 M	B. Wt. No. 8 M	B. Wt. No. 9 M	B. Wt. No. 10 F
March 12, 1940 ----	2.08 lbs.	2.37 lbs.	2.00 lbs.	2.53 lbs.	2.71 lbs.
March 13, 1940 ----	2.02 lbs.	2.21 lbs.	1.83 lbs.	2.40 lbs.	2.61 lbs.
March 14, 1940 ----	1.96 lbs. ED	2.03 lbs. D	1.67 lbs. D	2.22 lbs.	2.48 lbs.
March 15, 1940 ----				2.06 lbs. D	2.30 lbs.
March 16, 1940 ----					2.19 lbs. D

Env. Temp.—33° to 43° F. Air Mov.—0				
Dates	B. Wt. No. 11 F	B. Wt. No. 12 M	B. Wt. No. 13 M	B. Wt. No. 14 F
March 12, 1940 ----	—	—	—	—
March 13, 1940 ----	2.39 lbs.	2.26 lbs.	2.25 lbs.	2.30 lbs.
March 14, 1940 ----	2.30 lbs.	2.16 lbs.	2.11 lbs.	2.25 lbs.
March 15, 1940 ----	2.18 lbs.	2.04 lbs.	2.00 lbs.	2.18 lbs.
March 16, 1940 ----	2.06 lbs.	1.96 lbs.	1.94 lbs.	2.04 lbs.
March 17, 1940 ----	1.86 lbs.	1.80 lbs.	1.84 lbs.	1.89 lbs.
March 18, 1940 ----	1.86 lbs. D	1.71 lbs. D	1.69 lbs.	1.70 lbs.
March 19, 1940 ----			1.58 lbs. D	1.54 lbs.
March 20, 1940 ----				1.46 lbs. D

Notes: All animals without food or water at all times.

A—Actually died 3:00 P. M. March 13.

B—Actually died 4:00 P. M. March 14.

C—Actually died 3:30 P. M. March 15.

D—Indicates dead animal.

E—Actually died 4:00 P. M. March 13.

Percentages of initial body weights lost up to time of death: No. 1—11.3%, No. 2—6.0%, No. 3—16.2%, No. 4—14.0%, No. 5—15.5%, No. 6—5.8%, No. 7—14.3%, No. 8—16.5%, No. 9—18.6%, No. 10—19.2%, No. 11—22.2%, No. 12—24.3%, No. 13—29.8%, No. 14—36.5%.

habits must not be overlooked. Though it does not dig burrows itself, it commonly seeks the protection of holes and dens fashioned by other animals, particularly the common groundhog, or woodchuck. Field studies, combined with laboratory experimentation, have shown (Gerstell, 1939b) that these provide dry, windless, out-of-the way retreats, where the winter temperature range never falls below 25°F. or rises above 40°

TABLE XIV

FASTING EXPERIMENT—GREY FOX

(*Urocyon cinereoargenteus cinereoargenteus*)

Type Stock: Wild caught, captive reared, approximately 10 months of age.

Dates	Env. Temp. 0° F.	Env. Temp. 34°-50° F.
	Air Mov.—5.8 M.P.H.	Air Mov.—0
	Body Wt. No. 1 M	Body Wt. No. 2 M
March 4, 1940 ----	8.73 lbs.	9.57 lbs.
March 5, 1940 ----	8.50 lbs.	9.35 lbs.
March 6, 1940 ----	8.40 lbs.	9.07 lbs.
March 7, 1940 ----	8.22 lbs.	8.95 lbs.
March 8, 1940 ----	8.16 lbs.	8.89 lbs.
March 9, 1940 ----	8.00 lbs.	8.78 lbs.
March 10, 1940 ----	7.76 lbs.	8.68 lbs.
March 11, 1940 ----	7.36 lbs. D	8.61 lbs.
March 12, 1940 ----		8.46 lbs.
March 13, 1940 ----		8.11 lbs.
March 14, 1940 ----		7.44 lbs.
March 15, 1940 ----		7.08 lbs.
March 16, 1940 ----		6.83 lbs.
March 17, 1940 ----		6.68 lbs. D

Notes: Animals without food or water at all times.

D—Indicates dead animal.

Percentages of initial body weights lost up to time of death: No. 1—15.7%, No. 2—30.2%.

on the same scale. With such protection from exposure, or with even the wind shelter afforded by snow-covered brush piles or unusually dense patches of vegetation, the rabbit seems to fare quite well with even limited food supplies. Thus, since various forms of nutrients, particularly the tender bark of young, woody plants, are in most instances readily

secured in fair amounts, it would appear that the species can rarely, if ever, be expected to suffer heavy winter losses from cold and a shortage of food.

Grey Fox—Only one species of mammalian predator, the grey fox (*Urocyon cinereoargenteus cinereoargenteus*), including two individuals, was available for study purposes. Of the two wild caught, captive-reared foxes approximately 10 months of age, one was held at 0°F. with a 5.8 mile an hour wind without food or water, while the other was fasted under the usual control conditions. The recorded data are listed in Table XIV, page 57.

Study of the chart will reveal the fact that the experimental specimen succumbed toward the end of the seventh day (165 hours) of fasting at 84.3% of its initial weight, while the control individual perished on the thirteenth day (310 hours), having lost 30.2% of its starting weight.

Particularly in view of the protection and warmth provided by the foxes' home burrows, which have been previously discussed, it appears that individuals of this species can probably do without food for a week, or even ten days, without great hardship, even though active animals might suffer somewhat more than the 12.8% loss in average body weight exhibited at the end of one week by the two greys tested.

Muskrat—Three species of fur-bearing mammals were included in the fasting series, namely, the muskrat, the skunk and the opossum. A total of six wild trapped, male muskrats (*Ondatra zibethica zibethica*) was available for experimentation. Of these, two were fasted at 0°F. with a constant "wind" of 5.8 miles per hours, two at 0° with no "wind" and two were used as controls under "standard" conditions. A summary of the information gained is to be found in Table XV, page 59.

Even a glance at the figures will reveal the fact that the 'rat is one of the least hardy of the species studied. The two test animals subjected to the wind survived less than two days (approximately 40 hours), losing an average of 13.2% of their initial weights, while those not exposed to the wind lived almost twice as long, or just short of 4 days (over 90 hours), with an average loss of 20.7% in body weight.

The control specimens succumbed only after an average fast of a little more than eight days (200 hours) at an average of 70.0% of their starting weights. This, of course, is equal to four times the survival of the animals first discussed.

Though the tests clearly establish the fact that the muskrat's powers of enduring extremely low environmental temperatures are comparatively poor, it does not necessarily follow that the species is frequently decimated by periods of severe weather. Doubtless the animal's habits, which embrace a home in stream bank or reed house, where food is frequently stored and where temperatures probably seldom, if ever, fall below the

TABLE XV
FASTING EXPERIMENT—MUSKRAT
(*Ondatra zibethica zibethica*)
Type Stock: Wild trapped, unknown ages.

Dates	E. T.—0° F. Air Mov.—5.8 M.P.H.		E. T.—0° F. Air Mov.—0		E. T.—36°-48° F. Air Mov.—0	
	B. Wght. No. 1 M	B. Wght. No. 2 M	B. Wght. No. 3 M	B. Wght. No. 4 M	B. Wght. No. 5 M	B. Wght. No. 6 M
Apr. 2, 1941--	1.90 lbs.	1.95 lbs.	2.11 lbs.	2.39 lbs.	2.56 lbs.	2.81 lbs.
Apr. 3, 1941--	1.70 lbs.	1.72 lbs.	1.95 lbs.	2.24 lbs.	2.33 lbs.	2.64 lbs.
Apr. 4, 1941--	1.64 lbs. AD	1.70 lbs. AD	1.80 lbs.	2.12 lbs.	2.20 lbs.	2.52 lbs.
Apr. 5, 1941--			1.73 lbs.	1.99 lbs.	2.12 lbs.	2.43 lbs.
Apr. 6, 1941--			1.61 lbs. B	1.96 lbs. CD	2.01 lbs.	2.31 lbs.
Apr. 7, 1941--					1.89 lbs.	2.22 lbs.
Apr. 8, 1941--					1.82 lbs.	2.15 lbs.
Apr. 9, 1941--					1.80 lbs.	2.05 lbs.
Apr. 10, 1941--					1.76 lbs. D	2.02 lbs.
Apr. 11, 1941--						2.00 lbs. D

Notes: All animals without food or water at all times.

Experiment inaugurated at 1:00 P. M.

A—Record at 7:30 A. M. No. 1 dead only very short time.

B—Animal at point of death with rectal temperature of 57.3° F.

C—Record at 11:00 A. M.

D—Indicates dead animal.

Percentages of initial body weights lost up to time of death: No. 1—13.7%, No. 2—12.8%, No. 3—23.7%, No. 4—18.0%, No. 5—31.2%, No. 6—28.8%.

freezing point, together with active periods spent in or near open water, are such that it is only rarely faced with the problem of surviving extended periods of low temperature combined with food shortages.

Skunk—The common skunk, which in the total value of its annual fur sales is exceeded only by the muskrat, represents the second of the three fur-bearers studied. Eight individuals of this species (*Mephitis nigra*) were included in the fasting series. All were male specimens, some of which were wild caught and reared in captivity, while others were taken when adults. Although each was mature, no exact age records were available. Five of them were fasted at 0°F. with no air movement during January and February, 1940, while three were subjected to "standard" conditions without food or water during March of the same year. The results of the work are shown in Table XVI, page 60.

TABLE XVI
FASTING EXPERIMENTS—SKUNK
(*Mephitis nigra*)

Type Stock: Wild caught and captive reared, various ages.

Dates (1940)	Env. Temp.—0° F. Air Mov.—0					Dates (1940)	Env. Temp.—34°-50° F. Air Mov.—0		
	Body Weights (Lbs.)						Body Weights (Lbs.)		
	No. 1 M	No. 2 M	No. 3 M	No. 4 M	No. 5 M		No. 6 M	No. 7 M	No. 8 M
Jan. 18 ---	4.99	4.42	3.50	4.92	5.40	Mar. 1 --	3.50	5.37	5.65
Jan. 19 ---	4.73	4.11	3.19	4.64	5.28	Mar. 2 --	3.36	5.26	5.56
Jan. 20 ---	4.54	3.98	2.96	4.37	5.15	Mar. 3 --	3.27	5.14	5.45
Jan. 21 ---	4.35	3.85	2.88	4.26	5.10	Mar. 4 --	3.17	5.02	5.35
Jan. 22 ---	4.17	3.69	2.78	4.11	5.01	Mar. 5 --	3.12	4.92	5.27
Jan. 23 ---	4.05	3.54	2.67	4.00	4.99	Mar. 6 --	3.04	4.80	5.18
Jan. 24 ---	3.99 D	3.33	2.55	3.87	4.90	Mar. 7 --	2.97	4.70	5.10
Jan. 25 ---		3.12	2.46	3.75	4.81	Mar. 8 --	2.90	4.62	5.02
Jan. 26 ---		3.06 D	2.34	3.63	4.70	Mar. 9 --	2.80	4.51	4.95
Jan. 27 ---			2.24	3.53	4.65	Mar. 10 --	2.75	4.42	4.87
Jan. 28 ---			2.10	3.43	4.62	Mar. 11 --	2.52	4.34	4.81
Jan. 29 ---			1.98	3.35	4.55	Mar. 12 --	2.32 D	4.24	4.72
Jan. 30 ---			1.86	3.22	4.48	Mar. 13 --		4.18	4.69
Jan. 31 ---			1.77 D	3.13	4.40	Mar. 14 --		4.09	4.58
Feb. 1 ---				3.04	4.33	Mar. 15 --		3.96	4.51
Feb. 2 ---				2.94	4.26	Mar. 16 --		3.90	4.47
Feb. 3 ---				2.87	4.18	Mar. 17 --		3.84	4.39
Feb. 4 ---				2.79	4.10	Mar. 18 --		3.78	4.29
Feb. 5 ---				2.71	4.05	Mar. 19 --		3.70	4.22
Feb. 6 ---				2.61	3.96	Mar. 20 --		3.63	4.16
Feb. 7 ---				2.55	3.86	Mar. 21 --		3.57	4.11
Feb. 8 ---				2.46	3.75	Mar. 22 --		3.53	4.04
Feb. 9 ---				2.35	3.60	Mar. 23 --		3.46	3.97
Feb. 10 ---				2.28 R	3.45 R	Mar. 24 --		3.39	3.94
						Mar. 25 --		3.35	3.90
						Mar. 26 --		3.29	3.84
						Mar. 27 --		3.26	3.79
						Mar. 28 --		3.20	3.71
						Mar. 29 --		3.15	3.65
						Mar. 30 --		3.10	3.61
						Mar. 31 --		3.08	3.56
						Apr. 1 --		3.02	3.52
						Apr. 2 --		2.97	3.45
						Apr. 3 --		2.94	3.42
						Apr. 4 --		2.87	3.36
						Apr. 5 --		2.83	3.29
						Apr. 6 --		2.78	3.24
						Apr. 7 --		2.73	3.19
						Apr. 8 --		2.70	3.13
						Apr. 9 --		2.68	3.09
						Apr. 10 --		2.64	3.06
						Apr. 11 --		2.59	3.00
						Apr. 12 --		2.56	2.95
						Apr. 13 --		2.50	2.92
						Apr. 14 --		2.47	2.88
						Apr. 15 --		2.44	2.83
						Apr. 16 --		2.38	2.82
						Apr. 17 --		2.30	2.74
						Apr. 18 --		2.22	2.63
						Apr. 19 --		2.12	2.56
						Apr. 20 --		2.04 D	2.39
						Apr. 21 --			2.29 S

Notes: All animals without food or water at all times.

All animals males.

D—Indicates dead animal.

R—Animals removed from chamber in apparently good condition. The loss in weight was rapidly regained after feeding and complete recovery was effected.

S—Animal removed from chamber. Unconscious with rectal temperature of 67.8° F. Force fed and recovered. Percentage of initial body weights lost up to time of death or removal from chamber: No. 1—20.0%, No. 2—30.8%, No. 3—49.4%, No. 4—53.7%, No. 5—36.1%, No. 6—33.7%, No. 7—62.0%, No. 8—59.5%.

The records clearly indicate that the "polecat" is among the hardest of the species utilized in the experimental work. The minimum period of survival for the animals held at zero was nearly six days (roughly 140 hours), the average just over 15 days (about 365 hours), while two lived through 23 full days (over 550 hours) without food or water, later completely recovering therefrom. The minimum loss of 20.0% in body weight was exhibited by the animal which perished first. The maximum loss, totaling 53.7% was suffered by one of the individuals fasting for 23 days, but the second highest was evidenced by Specimen No. 3, which died on the twelfth day at 50.6% of its initial weight. The average loss for all five was 36.6%.

In the control group, one skunk died on the eleventh day (after fasting roughly 260 hours), the second perished on the fiftieth day (1200 hours), while the third survived 51 full days of fasting (1224 hours). The first mentioned lost 33.7% in body weight, the second 62.0% and the third 59.5%. The average time of survival was 37.3 days (895 hours), while the average weight loss was 54.2%. Here it is significant to note that an active mammal was reduced to approximately 40% of its initial weight, that its body temperature dropped more than 30°F. below normal, but that as a result of forced feeding complete recovery was effected.

From the data presented, it is obvious that winter losses, caused by severe weather and food shortages, cannot be expected among skunks. In fact, in the northern section of their range, they frequently remain "dennd up," doubtless in at least semi-, if not true, hibernation, for as long as 90 days, thus evading entirely the most severe climatic conditions of winter. During such periods of inactivity, it is probable that the loss in body weight is more gradual than that exhibited by the active specimens herein described.

Opossum—The third fur-bearing species experimented with was the opossum (*Didelphis virginiana virginiana*). Eight mature specimens, all wild caught, but some captive reared, were tested simultaneously with the skunks. One male and five females of unknown ages were held without food or water at 0°F. with a "wind" of 1.1 miles per hour constantly blowing over them, while two females were fasted under the previously described set of standard winter conditions. The records for each individual are summarized in Table XVII, page 62.

The average period of survival for the test animals was 12.8 days (about 305 hours), with a minimum of not quite three (about 65 hours) and a maximum of approximately 17 days (400 hours). Strange to say, these figures are almost identical to those for the great horned owl (see page 62). The minimum loss in body weight was 8.7%, the maximum 41.2% and the average 33.5%.

TABLE XVII
FASTING EXPERIMENTS—OPOSSUM
(*Didelphis virginiana virginiana*)

Type Stock: Wild caught, wild caught and captive reared, various ages.

Environmental Temperature—0° F. Air Movement—1.1 M.P.H.							Env. Temp.—34° to 50° F. Air Mov.—0		
Dates	B. Wt. No. 1 F	B. Wt. No. 2 M	B. Wt. No. 3 F	B. Wt. No. 4 F	B. Wt. No. 5 F	B. Wt. No. 6 F	Dates	B. Wt. No. 7 F	M. Wt. No. 8 F
Jan. 18, 1940	3.11 lbs.	3.50 lbs.	4.25 lbs.	4.43 lbs.	2.58 lbs.	3.95 lbs.	Mar. 1, 1940	3.53 lbs.	6.77 lbs.
Jan. 19, 1940	2.92 lbs.	3.34 lbs.	4.00 lbs.	4.32 lbs.	2.56 lbs.	3.83 lbs.	Mar. 2, 1940	3.36 lbs.	6.54 lbs.
Jan. 20, 1940	2.85 lbs.	3.15 lbs.	3.78 lbs.	4.07 lbs.	2.49 lbs.	3.68 lbs.	Mar. 3, 1940	3.19 lbs.	6.25 lbs.
Jan. 21, 1940	2.84 lbs. D	3.05 lbs.	3.67 lbs.	4.02 lbs.	2.44 lbs.	3.63 lbs.	Mar. 4, 1940	3.06 lbs.	6.10 lbs.
Jan. 22, 1940		2.97 lbs.	3.55 lbs.	3.90 lbs.	2.36 lbs.	3.52 lbs.	Mar. 5, 1940	2.96 lbs.	5.98 lbs.
Jan. 23, 1940		2.88 lbs.	3.43 lbs.	3.86 lbs.	2.34 lbs.	3.39 lbs.	Mar. 6, 1940	2.80 lbs.	5.82 lbs.
Jan. 24, 1940		2.74 lbs.	3.33 lbs.	3.68 lbs.	2.30 lbs.	3.30 lbs.	Mar. 7, 1940	2.69 lbs.	5.67 lbs.
Jan. 25, 1940		2.62 lbs.	3.24 lbs.	3.54 lbs.	2.23 lbs.	3.22 lbs.	Mar. 8, 1940	2.62 lbs.	5.60 lbs.
Jan. 26, 1940		2.51 lbs.	3.14 lbs.	3.40 lbs.	2.21 lbs.	3.16 lbs.	Mar. 9, 1940	2.50 lbs.	5.45 lbs.
Jan. 27, 1940		2.39 lbs.	3.02 lbs.	3.34 lbs.	2.12 lbs.	3.12 lbs.	Mar. 10, 1940	2.43 lbs.	5.33 lbs.
Jan. 28, 1940		2.26 lbs.	2.91 lbs.	3.29 lbs.	2.10 lbs.	2.96 lbs.	Mar. 11, 1940	2.37 lbs. AD	5.20 lbs.
Jan. 29, 1940		2.21 lbs. D	2.81 lbs.	3.16 lbs.	2.03 lbs.	2.90 lbs.	Mar. 12, 1940		5.09 lbs.
Jan. 30, 1940			2.72 lbs.	3.09 lbs.	1.99 lbs.	2.82 lbs.	Mar. 13, 1940		4.97 lbs.
Jan. 31, 1940			2.59 lbs.	3.00 lbs.	1.92 lbs.	2.77 lbs.	Mar. 14, 1940		4.86 lbs.
Feb. 1, 1940			2.50 lbs. D	2.92 lbs.	1.88 lbs.	2.71 lbs.	Mar. 15, 1940		4.73 lbs.
Feb. 2, 1940				2.80 lbs.	1.86 lbs.	2.61 lbs.	Mar. 16, 1940		4.62 lbs.
Feb. 3, 1940				2.75 lbs. D	1.87 lbs.	2.48 lbs.	Mar. 17, 1940		4.53 lbs.
Feb. 4, 1940					1.78 lbs. D	2.44 lbs. D	Mar. 18, 1940		4.41 lbs.
							Mar. 19, 1940		4.30 lbs.
							Mar. 20, 1940		4.18 lbs.
							Mar. 21, 1940		4.13 lbs.
							Mar. 22, 1940		4.01 lbs.
							Mar. 23, 1940		3.93 lbs.
							Mar. 24, 1940		3.84 lbs.
							Mar. 25, 1940		3.81 lbs. D

Notes: All animals without food or water at all times.

A—Body temperature (rectal) just before death, 65.3° F.

D—Indicates dead animal.

Percentages of initial body weights lost up to time of death: No. 1—8.7%, No. 2—36.9%, No. 3—41.2%, No. 4—37.9%, No. 5—31.1%, No. 6—38.2%, No. 7—32.9%, No. 8—43.7%.

Notes: All animals without food or water at all times.

A—Body temperature (rectal) just before death, 65.3° F.

D—Indicates dead animal.

Percentages of initial body weights lost up to time of death: No. 1—8.7%, No. 2—36.9%, No. 3—41.2%, No. 4—37.9%, No. 5—31.1%, No. 6—38.2%, No. 7—32.9%, No. 8—43.7%.

Of the two control specimens, both females, one survived nearly 10 days (about 240 hours), the other almost 24 days (roughly 575 hours), or an average of 17 days (408 hours). The body loss for the first was 32.9%, the second 43.7% and the average 40.0%.

The opossum represents another comparatively hardy species. Cognizant of the fact that these animals often remain inactive for several days, "asleep" in some relatively warm, wind-free den, during unusually severe periods and realizing that the average weight loss exhibited by all specimens except No. 1 was only 20.5% at the end of the first week of fasting, it would seem reasonable to assume that this species also can undergo a full week, or possibly more, of severe weather fasting without suffering seriously therefrom.

Effects of Fasting on Fecundity—A point stressed in practically all literature designed to encourage participation in various winter feeding programs is that game "must be carried through the winter in good condition" in order to render the birds and mammals capable of normal propagation during the following spring and summer. From evidence now at hand, however, it appears that the validity of this generalization is open to question.

Roger M. Latham, John D. Beule and the writer have been investigating for several years various phases of the effects of severe winters upon wildlife. This work is being conducted at the Pennsylvania Game Commission's Loyalsock Experiment Station. Though the proposed program will not be completed and the findings published for several years, certain of the experiments conducted in connection therewith under the author's direction are briefly discussed below.

During the late winter, spring and summer of 1940, an effort was made to determine the effects of winter food shortages on the breeding of pheasants. A total of 36 wild trapped rinknecks (*Phasianus colchicus torquatus*) of unknown ages with a minimum of nine months was used in the work. Divided as accurately as possible into two equal groups, each containing three males and 15 females, one lot was used for experimental and the other for control purposes.

All individuals in the first mentioned division were subject to two periods of fasting wherein no food was offered them, though water was frequently available in the form of snow or rain. The check specimens were constantly allowed to partake *ad libitum* of scratch feed and water. The first fast, of eight days' duration, extended from mid-morning March 10 to the corresponding time on March 18. This was followed by a normal period of feeding which lasted until the morning of April 4, when the second fast was inaugurated. The latter was six days in length, ending before noon on April 10 when feeding was resumed. To check the effects of the fasts as reflected by changes in the body weights of the

birds, all specimens were weighed on March 10 and 18 as well as on April 4 and 10. The resulting data are listed on Table XVIII, page 65.

On March 10, the weights of the experimental birds ranged from 1.87 to 3.23, with an average of 2.36 pounds. The comparable figures for the control group were 1.96, 2.77 and 2.24 pounds, respectively. By the end of the first period without food on March 18, the test birds exhibited a maximum weight of 2.51, a minimum of 1.12 and an average of 1.78 pounds. As would naturally be expected, all the pheasants evidenced appreciable losses in body weight. Expressed in percentages of their weight on March 10, these ranged from a low of 16.1% to a high of 46.2%, with an aggregate of 24.6%. During the same period, the control birds exhibited gains in weight. The maximum figure had risen to 2.94, the minimum to 1.94 and the average to 2.37 pounds. Three individuals showed small losses, while the others gained from 2.5% to 16.3% of their March 10 weights. The collective change represented an increase of 5.8%.

The April 4 figures show that the experimental birds had all gained weight during the feeding period. The individual making the smallest gain weighed only 71.2% of its March 10 total, while that exhibiting the largest was at 106.5% of its starting figure. The collective total was 96.6% of that for March 10. The individual weights extended from 1.48 to 3.21, with an average of 2.28 pounds. On the other hand, the control birds evidenced little change from March 18 to April 4, though their collective weight on the latter date was 106.2% of the corresponding figure for March 10.

At the end of the second fasting period on April 10, the weights of the test specimens ranged from 0.98 to 2.59, with an average of 1.94 pounds. The collective weight loss was 14.9% of the April 4 total, while the minimum was 11.5% and the maximum 33.8%. During the same period, the control group evidenced a collective loss of 2.5% of their April 4 figure. The individual changes ranged from a loss of 11.3% to a gain of 5.2%.

In summary it may be said that during an eight-day fast ending March 18, the experimental birds were reduced to 75.4% of their initial weight. For the same interval the control group exhibited a gain equal to 5.8% of their starting weight. Within a feeding period initiated immediately following the close of the first foodless period and extending until April 4, a total of 17 days, the test lot reached a point equal to 96.6% of its March 10 weight. On the same date, the controls were at 106.2% of their initial figure. At the close of the second period of fasting on April 10, the birds without food had been reduced to 85.1% of their April 4 total (82.2% of weight March 10), while the check individuals were at 97.5% of their April 4 figure (103.6% of March 10 weight). In other

TABLE XVIII
FASTING DATA—PRECEDING MATING AND EGG PRODUCTION—RINGNECK PHEASANT
(*Phasianus colchicus torquatus*)

Type Stock: Wild trapped, various ages with minimum of 9 months.

Experimental Birds—2 Periods of Fasting							
1st Fast—March 10 to 18, 1940				2nd Fast—April 4 to 10, 1940			
Sex	Initial Weights March 10	Weights March 18	% Initial Weight Lost	Weights April 4	% Initial Weight Regain	Weights April 10	% Weight Lost from April 4
M	3.23 lbs.	2.51 lbs.	22.3%	3.21 lbs.	99.4%	2.59 lbs.	19.3%
M	2.92 lbs.	2.22 lbs.	24.0%	2.72 lbs.	93.2%	2.35 lbs.	13.6%
M	2.80 lbs.	1.74 lbs.	37.9%	2.36 lbs.	84.3%	2.08 lbs.	19.9%
F	2.43 lbs.	1.84 lbs.	24.3%	2.32 lbs.	95.5%	1.96 lbs.	15.5%
F	2.42 lbs.	2.03 lbs.	16.1%	2.48 lbs.	102.5%	2.23 lbs.	11.1%
F	2.41 lbs.	1.90 lbs.	21.2%	2.40 lbs.	99.6%	2.06 lbs.	14.2%
F	2.41 lbs.	1.85 lbs.	23.3%	2.41 lbs.	100.0%	2.03 lbs.	15.8%
F	2.35 lbs.	1.90 lbs.	19.2%	2.38 lbs.	101.3%	2.10 lbs.	11.8%
F	2.34 lbs.	1.89 lbs.	19.2%	2.39 lbs.	102.1%	2.06 lbs.	13.8%
F	2.30 lbs.	1.88 lbs.	18.3%	2.42 lbs.	105.2%	2.10 lbs.	13.2%
F	2.29 lbs.	1.81 lbs.	21.0%	2.34 lbs.	102.2%	2.07 lbs.	11.5%
F	2.23 lbs.	1.69 lbs.	24.2%	2.18 lbs.	97.8%	1.88 lbs.	13.8%
F	2.16 lbs.	1.78 lbs.	17.6%	2.30 lbs.	106.5%	1.92 lbs.	16.5%
F	2.11 lbs.	1.66 lbs.	21.4%	2.03 lbs.	96.2%	1.72 lbs.	15.3%
F	2.09 lbs.	1.63 lbs.	22.0%	2.03 lbs.	97.1%	1.73 lbs.	15.3%
F	2.08 lbs.	1.12 lbs.	46.2%	1.48 lbs.	71.2%	.98 lbs.	33.8%
F	2.04 lbs.	1.54 lbs.	24.5%	2.01 lbs.	98.5%	1.69 lbs.	15.3%
F	1.87 lbs.	1.13 lbs.	39.6%	1.61 lbs.	86.1%	1.39 lbs.	13.7%
Av.	2.36 lbs.	1.78 lbs.	24.6%	2.23 lbs.	96.6%	1.94 lbs.	14.9%
Control Birds—No Fasting							
Sex	Initial Weights March 10	Weights March 18	% Change from Initial Weight	Weights April 4	% March 10 Weight Exhibited on April 4	Weights April 10	% Weight Lost from April 4
M	2.77 lbs.	2.94 lbs.	+6.1%	2.97 lbs.	107.2%	2.90 lbs.	-2.4%
M	2.67 lbs.	2.84 lbs.	+6.4%	2.86 lbs.	107.1%	2.80 lbs.	-2.1%
M	2.65 lbs.	2.93 lbs.	+10.6%	2.88 lbs.	108.7%	2.81 lbs.	-2.4%
F	2.55 lbs.	2.88 lbs.	+12.9%	3.00 lbs.	117.6%	3.05 lbs.	+1.7%
F	2.41 lbs.	2.54 lbs.	+5.4%	2.57 lbs.	106.6%	2.56 lbs.	-0.4%
F	2.33 lbs.	2.58 lbs.	+10.7%	2.55 lbs.	109.4%	2.46 lbs.	-3.5%
F	2.27 lbs.	2.64 lbs.	+16.3%	2.62 lbs.	115.4%	2.46 lbs.	-6.1%
F	2.27 lbs.	2.46 lbs.	+8.4%	2.51 lbs.	110.6%	2.36 lbs.	-6.0%
F	2.11 lbs.	2.23 lbs.	+5.7%	2.30 lbs.	109.0%	2.22 lbs.	-3.5%
F	2.11 lbs.	2.06 lbs.	-2.4%	2.06 lbs.	97.6%	2.00 lbs.	-2.9%
F	2.09 lbs.	2.21 lbs.	+5.7%	1.91 lbs.	91.4%	2.01 lbs.	+5.2%
F	2.07 lbs.	2.15 lbs.	+3.9%	2.21 lbs.	106.8%	2.22 lbs.	+0.5%
F	2.06 lbs.	2.17 lbs.	+5.3%	2.27 lbs.	110.2%	2.27 lbs.	0.0%
F	2.05 lbs.	2.00 lbs.	-2.4%	2.01 lbs.	98.0%	1.90 lbs.	-5.5%
F	2.00 lbs.	2.05 lbs.	+2.5%	2.16 lbs.	108.0%	2.12 lbs.	-1.9%
F	2.00 lbs.	1.98 lbs.	-1.0%	1.95 lbs.	97.5%	1.73 lbs.	-11.3%
F	1.96 lbs.	2.10 lbs.	+7.1%	2.14 lbs.	109.2%	2.05 lbs.	-4.2%
F	1.96 lbs.	1.94 lbs.	-1.0%	1.89 lbs.	96.4%	1.78 lbs.	-5.8%
Av.	2.24 lbs.	2.37 lbs.	+5.8%	2.38 lbs.	106.2%	2.32 lbs.	-2.5%

Note: All birds fed and watered *ad libitum* except during two periods of fast when all food was removed from experimentals, while only snow and rain supplied water.

words, the test pheasants were subjected to an eight-day fast in mid-March. This resulted in a loss of approximately 25% of their aggregate body weight. During the 17 days immediately following, they were provided with scratch feed, exhibiting a constant gain in body weight which reached on April 4 a point equal to 96.6% of their total weight immediately preceding the March fast. They were then fasted a second time for six days. During this period they suffered a weight drop of roughly 15%.

From April 10 forward, both groups of ringnecks were constantly provided with scratch feed and water, while an accurate record of the egg production of each was carefully maintained. A summary of the laying data is given in Table XIX, page 67.

The first egg was produced by the control group on April 18. Additional ones from this lot were not forthcoming until April 23 when four were laid. The earliest eggs, three in number, from the experimental hens



Figure 11. A male ringneck feeding on an ear of field corn placed on the sharpened end of a twig.

were laid May 2, 22 days after the close of the second period of fasting. Five additional were produced the following day.

In this connection, nesting records of wild birds in the field are of significance. It has been the writer's experience in Pennsylvania that during any given year diligent search between April 15 and 20 will reveal

TABLE XIX
EGG PRODUCTION—FASTED AND NORMAL BIRDS—RINGNECK PHEASANT
(*Phasianus colchicus torquatus*)

Type Stock: Wild trapped, various ages with minimum of 12 months.

Daily and Average Production—Experimental (E) and Control (C) Groups
(Each Group with 3 Males and 15 Females)

Date	(C)	(E)	Date	(C)	(E)	Date	(C)	(E)	Date	(C)	(E)
Apr. 16, 1940--	—	—	May 1, 1940--	4	—	May 16, 1940--	7	7	June 1, 1940--	5	10
Apr. 17, 1940--	—	—	May 2, 1940--	3	3	May 17, 1940--	9	7	June 2, 1940--	3	5
Apr. 18, 1940--	1	—	May 3, 1940--	3	5	May 18, 1940--	5	9	June 3, 1940--	12	11
Apr. 19, 1940--	—	—	May 4, 1940--	—	—	May 19, 1940--	6	10	June 4, 1940--	9	11
Apr. 20, 1940--	—	—	May 5, 1940--	3	4	May 20, 1940--	9	11	June 5, 1940--	9	12
Apr. 21, 1940--	—	—	May 6, 1940--	5	4	May 21, 1940--	5	10	June 6, 1940--	5	11
Apr. 22, 1940--	—	—	May 7, 1940--	5	5	May 22, 1940--	11	11	June 7, 1940--	6	8
Apr. 23, 1940--	4	—	May 8, 1940--	5	6	May 23, 1940--	8	7	June 8, 1940--	9	10
Apr. 24, 1940--	1	—	May 9, 1940--	7	6	May 24, 1940--	4	10	June 9, 1940--	9	12
Apr. 25, 1940--	—	—	May 10, 1940--	4	6	May 25, 1940--	7	10	June 10, 1940--	8	12
Apr. 26, 1940--	1	—	May 11, 1940--	8	7	May 26, 1940--	5	7	June 11, 1940--	8	6
Apr. 27, 1940--	2	—	May 12, 1940--	7	7	May 27, 1940--	3	10	June 12, 1940--	9	12
Apr. 28, 1940--	—	—	May 13, 1940--	5	8	May 28, 1940--	3	4	June 13, 1940--	8	13
Apr. 29, 1940--	2	—	May 14, 1940--	10	8	May 29, 1940--	4	11	June 14, 1940--	12	9
Apr. 30, 1940--	2	—	May 15, 1940--	8	8	May 30, 1940--	4	10	June 15, 1940--	8	9
	—	—		—	—	May 31, 1940--	4	7		—	—
Total -----	13	0		77	77		94	141		120	151
Grand total ---	13	0		90	77		184	218		304	369
Per. Av. A ----	.07	.00		.34	.36		.39	.59		.53	.67
Run. Av. B ---	.07	.00		.21	.36		.27	.48		.34	.55

Date	(C)	(E)	Date	(C)	(E)	Date	(C)	(E)
June 16, 1940-----	10	11	July 1, 1940-----	3	3	July 16, 1940-----	4	2
June 17, 1940-----	8	12	July 2, 1940-----	5	5	July 17, 1940-----	3	5
June 18, 1940-----	5	13	July 3, 1940-----	5	4	July 18, 1940-----	3	3
June 19, 1940-----	9	12	July 4, 1940-----	5	11	July 19, 1940-----	3	5
June 20, 1940-----	9	12	July 5, 1940-----	7	5	July 20, 1940-----	4	3
June 21, 1940-----	5	8	July 6, 1940-----	4	4	July 21, 1940-----	4	3
June 22, 1940-----	9	10	July 7, 1940-----	6	6	July 22, 1940-----	4	3
June 23, 1940-----	8	10	July 8, 1940-----	7	6	July 23, 1940-----	—	—
June 24, 1940-----	3	8	July 9, 1940-----	2	6	July 24, 1940-----	—	—
June 25, 1940-----	8	11	July 10, 1940-----	3	4	July 25, 1940-----	—	—
June 26, 1940-----	4	9	July 11, 1940-----	3	5	July 26, 1940-----	16*	20*
June 27, 1940-----	9	10	July 12, 1940-----	5	5	July 27, 1940-----	—	—
June 28, 1940-----	6	2	July 13, 1940-----	5	4	July 28, 1940-----	—	—
June 29, 1940-----	5	7	July 14, 1940-----	4	5	July 29, 1940-----	—	—
June 30, 1940-----	6	6	July 15, 1940-----	2	5	July 30, 1940-----	—	—
Total -----	104	141		66	78		41	44
Grand total -----	408	510		474	588		515	632
Per. Av. A -----	.46	.63		.29	.35		.20	.21
Run. Av. B -----	.37	.57		.36	.52		.33	.47

Notes: *Actually covers the period from July 23 to 29, inclusive.
A—Indicates average number eggs laid per hen per day per half month period.
B—Indicates average number eggs laid per hen per day from day first egg was laid.

words, the test pheasants were subjected to an eight-day fast in mid-March. This resulted in a loss of approximately 25% of their aggregate body weight. During the 17 days immediately following, they were provided with scratch feed, exhibiting a constant gain in body weight which reached on April 4 a point equal to 96.6% of their total weight immediately preceding the March fast. They were then fasted a second time for six days. During this period they suffered a weight drop of roughly 15%.

From April 10 forward, both groups of ringnecks were constantly provided with scratch feed and water, while an accurate record of the egg production of each was carefully maintained. A summary of the laying data is given in Table XIX, page 67.

The first egg was produced by the control group on April 18. Additional ones from this lot were not forthcoming until April 23 when four were laid. The earliest eggs, three in number, from the experimental hens



Figure 11. A male ringneck feeding on an ear of field corn placed on the sharpened end of a twig.

were laid May 2, 22 days after the close of the second period of fasting. Five additional were produced the following day.

In this connection, nesting records of wild birds in the field are of significance. It has been the writer's experience in Pennsylvania that during any given year diligent search between April 15 and 20 will reveal

TABLE XIX
EGG PRODUCTION—FASTED AND NORMAL BIRDS—RINGNECK PHEASANT
(*Phasianus colchicus torquatus*)

Type Stock: Wild trapped, various ages with minimum of 12 months.

Daily and Average Production—Experimental (E) and Control (C) Groups
(Each Group with 3 Males and 15 Females)

Date	(C)	(E)	Date	(C)	(E)	Date	(C)	(E)	Date	(C)	(E)
Apr. 16, 1940..	—	—	May 1, 1940..	4	—	May 16, 1940..	7	7	June 1, 1940..	5	10
Apr. 17, 1940..	—	—	May 2, 1940..	3	3	May 17, 1940..	9	7	June 2, 1940..	3	5
Apr. 18, 1940..	1	—	May 3, 1940..	3	5	May 18, 1940..	5	9	June 3, 1940..	12	11
Apr. 19, 1940..	—	—	May 4, 1940..	—	—	May 19, 1940..	6	10	June 4, 1940..	9	11
Apr. 20, 1940..	—	—	May 5, 1940..	3	4	May 20, 1940..	9	11	June 5, 1940..	9	12
Apr. 21, 1940..	—	—	May 6, 1940..	5	4	May 21, 1940..	5	10	June 6, 1940..	5	11
Apr. 22, 1940..	—	—	May 7, 1940..	5	5	May 22, 1940..	11	11	June 7, 1940..	6	8
Apr. 23, 1940..	4	—	May 8, 1940..	5	6	May 23, 1940..	8	7	June 8, 1940..	9	10
Apr. 24, 1940..	1	—	May 9, 1940..	7	6	May 24, 1940..	4	10	June 9, 1940..	9	12
Apr. 25, 1940..	—	—	May 10, 1940..	4	6	May 25, 1940..	7	10	June 10, 1940..	8	12
Apr. 26, 1940..	1	—	May 11, 1940..	8	7	May 26, 1940..	5	7	June 11, 1940..	8	6
Apr. 27, 1940..	2	—	May 12, 1940..	7	7	May 27, 1940..	3	10	June 12, 1940..	9	12
Apr. 28, 1940..	—	—	May 13, 1940..	5	8	May 28, 1940..	3	4	June 13, 1940..	8	13
Apr. 29, 1940..	2	—	May 14, 1940..	10	8	May 29, 1940..	4	11	June 14, 1940..	12	9
Apr. 30, 1940..	2	—	May 15, 1940..	8	8	May 30, 1940..	4	10	June 15, 1940..	8	9
						May 31, 1940..	4	7			
Total	13	0		77	77		94	141		120	151
Grand total	13	0		90	77		184	218		304	360
Per. Av. A .....	.07	.00		.34	.36		.39	.59		.53	.67
Run. Av. B .....	.07	.00		.21	.36		.27	.48		.34	.55

Date	(C)	(E)	Date	(C)	(E)	Date	(C)	(E)
June 16, 1940..	10	11	July 1, 1940..	3	3	July 16, 1940..	4	2
June 17, 1940..	8	12	July 2, 1940..	5	5	July 17, 1940..	3	5
June 18, 1940..	5	13	July 3, 1940..	5	4	July 18, 1940..	2	3
June 19, 1940..	9	12	July 4, 1940..	5	11	July 19, 1940..	3	5
June 20, 1940..	9	12	July 5, 1940..	7	5	July 20, 1940..	4	3
June 21, 1940..	5	8	July 6, 1940..	4	4	July 21, 1940..	4	3
June 22, 1940..	9	10	July 7, 1940..	6	6	July 22, 1940..	4	3
June 23, 1940..	8	10	July 8, 1940..	7	6	July 23, 1940..	—	—
June 24, 1940..	3	8	July 9, 1940..	2	6	July 24, 1940..	—	—
June 25, 1940..	8	11	July 10, 1940..	3	4	July 25, 1940..	—	—
June 26, 1940..	4	9	July 11, 1940..	3	5	July 26, 1940..	16*	20*
June 27, 1940..	9	10	July 12, 1940..	5	5	July 27, 1940..	—	—
June 28, 1940..	6	2	July 13, 1940..	5	4	July 28, 1940..	—	—
June 29, 1940..	5	7	July 14, 1940..	4	5	July 29, 1940..	—	—
June 30, 1940..	6	6	July 15, 1940..	2	5	July 30, 1940..	—	—
Total	104	141		66	78		41	44
Grand total	408	510		474	588		515	632
Per. Av. A .....	.46	.63		.29	.35		.20	.21
Run. Av. B .....	.37	.57		.36	.52		.33	.47

Notes: *Actually covers the period from July 23 to 29, inclusive.
A—Indicates average number eggs laid per hen per day per half month period.
B—Indicates average number eggs laid per hen per day from day first egg was laid.

ringneck pheasant nests containing from one to four eggs. Though actual laying in the wild has been recorded as early as April 6 (Randall, 1941), it appears that a large percentage of the birds' first eggs are normally laid during the last half of April. Thus, initial production by the controls may well be considered normal and that for the experimentals delayed approximately 10 days.

If the laying period be considered in half-month spans for purposes of discussion, it is found that both groups reached maximum production during the first half of June. It is, however, of especial interest to note that the average for the period was 0.67 eggs per hen per day for the experimentals, as compared to 0.53 for the controls. Though not reached until June 13, the maximum daily production (15 hens) of the former lot was 13, while the latter produced a top of only 12.

Though no accurate record is available, it is definitely known that both groups of birds stopped laying between July 22 and July 30, as eggs were gathered from each on the 22nd and the 29th. This is probably as late as, if not later than, the time at which the last eggs are laid by birds in the wild.

During the entire season, the fasted birds produced a grand total of 632 eggs, or an average of 42.1 per hen. On the other hand, the control specimens averaged only 34.3 eggs per hen, totaling 515 in all. Computed from the day the first eggs were laid until the last were gathered on July 29, the average daily production by the experimentals was 0.47 eggs per hen per day for 89 days, while that for the controls was 0.33 for 103 days.

From the figures above presented, it is seen that the fasted individuals began to lay two weeks later than the normal birds; that they reached maximum production at the same time as the checks; but that they produced more eggs per day and per hen, as well as a larger total of eggs, than did the unfasted specimens.

Of all eggs laid by the two groups of pheasants, as many as could be fitted into an already heavy hatching schedule were checked for fertility and hatchability under identical conditions. The data obtained are listed in Table XX, page 69.

The equipment used in incubation included still-air and forced-draft machines, though all actual hatching operations were carried out in units of the first-mentioned type. Without exception, strictly comparable selections of eggs from both the fasted and normal pheasant groups were simultaneously placed in the incubators at convenient intervals and were identically treated throughout the entire period of incubation. As a general rule, the settings contained only eggs laid within the previous week, though limited numbers as old as 12 days were utilized. All infertile eggs were "candled-out" and counted on the twentieth day of incu-

TABLE XX

INCUBATION DATA—FASTED AND NORMAL BIRDS—RINGNECK PHEASANT

(*Phasianus colchicus torquatus*)

Type Stock: Wild trapped, various ages with minimum of 12 months.

Results of Settings—Eggs from Fasted (E) and Normal (C) Birds														
Dates of Settings	Total Numbers Eggs Set		Numbers Fertile Eggs		Percentage Fertility		Chicks Dead in Shell		Percentage D. L. S. (A)		Chicks Hatched		Percentage Hatched (B)	
	(E)	(C)	(E)	(C)	(E)	(C)	(E)	(C)	(E)	(C)	(E)	(C)	(E)	(C)
May 4, 1940-----	8	23	7	12	87.5%	52.2%	1	5	14.3%	41.7%	6	7	85.7%	59.3%
May 15, 1940-----	69	57	57	46	82.6%	80.7%	5	9	8.8%	19.6%	52	37	91.2%	80.4%
June 4, 1940-----	92	57	76	46	82.6%	80.7%	10	10	13.2%	21.7%	66	36	86.8%	78.3%
June 9, 1940-----	34	20	30	17	88.2%	85.0%	7	4	23.3%	23.5%	23	13	76.7%	76.5%
June 29, 1940-----	133	88	95	66	71.4%	75.0%	25	36	26.3%	54.5%	70	30	73.7%	44.5%
July 6, 1940-----	35	30	24	22	68.6%	73.3%	16	13	66.7%	50.1%	8	9	33.3%	40.9%
July 18, 1940-----	56	47	21	23	37.5%	48.9%	21	23	100.0%	100.0%	0	0	0.0%	0.0%
Totals -----	427	322	310	232	72.6%	72.0%	85	100	27.4%	43.1%	225	132	72.6%	56.9%

Notes: For the fasted birds (E), 427 represents 67.6% of all (632) eggs laid, while for the normal birds (C), 322 represents 92.5% of all (348) eggs laid.

A—Represents percentage of fertile eggs containing chicks dead in shell.

B—Represents percentage of fertile eggs which hatched.

bation, when eggs in the forced-draft machines were normally transferred to the hatchers.

The hatching schedule allowed for the setting of 427, or 67.6%, of the eggs from the fasted hens and 322, or 62.5%, of those from the control group.

Of the experimental eggs, 310, or 72.6%, proved fertile, while 232, or 72.0% of the controls were also capable of producing chicks. Thus, there was no significant difference in respect to fertility of the eggs produced by the two lots of birds. Furthermore, in view of the facts that the birds were fed only dried grains and that many late-season eggs were included, the percentage of fertile eggs appears normal. It is, however, interesting to note that only in the last three settings, June 29, July 6 and 18, was the fertility of the controls higher than that of the experimentals. In this connection, it must in all fairness be stated that the low fertility record of the controls in the first setting on May 4 may well be in part accounted for by the fact that the earliest eggs of the type in question had been held unusually long before setting.

From the 310 fertile eggs in the test group, 225 chicks were secured. Thus, 72.6% of the fertile eggs hatched, while 85, or 27.4%, contained dead embryos. Of the 232 fertiles in the control lot, only 132, or 56.9%, hatched, while the remaining 100, or 43.1%, contained chicks which had died in the shell. In this instance, the fact should be noted that only in the last two hatches did the records for the controls equal or exceed those of the experimentals. Certainly the difference in hatchability of the two types of eggs is significant, but it cannot be explained with the information at hand. In this connection, it must be stated that the comparatively poor hatching record for both groups was undoubtedly largely the result of faulty electrical supply service which rendered proper operation of the incubators and hatchers impossible.

The experiment may briefly be summarized by saying that a group of pheasants fasted for eight days in March and for six in April produced more eggs with a higher percentage of hatchability than did a comparable group constantly fed *ad libitum*.

Also in the case of ringnecks, it may be stated that eleven of the hen pheasants fasted for 35 days in January and February, 1941, as previously described, were checked as to fecundity during the breeding season immediately following. Though a number of the birds had lost over 50% in body weight during the period of fasting, their production records equaled those of unfasted birds of the same age and type.

Similarly, male and female mallard ducks, which had been fasted from five to 24 days and lost from 20.1% to 46.5% of their body weights as a result thereof (see page 50), apparently were not appreciably affected in respect to their breeding powers. Within a few hours after removal from

the fasting experiment, the birds were released on a pond on the grounds of the Experimental Station where they were wont to remain. Almost without exception, their first nests were destroyed by predators principally crows. A number of the birds re-nested, however, and were finally successful in bringing off broods of young.

On the other hand, experiments with bobwhite quail clearly seem to indicate that winter food shortages may have a pronounced effect on the reproductive powers of the species. In some instances, quail fasted during the winter months quickly regained heavy losses in body weight when food was again made available, only inexplicably to perish at the onset of the normal egg-laying season.

Shortages of high quality winter foods are also definitely known to effect the reproduction of whitetailed deer. Field studies conducted dur-



Figure 12. A second view of the pheasant in Figure 9.

ing recent years (Gerstell, 1936 and 1940) have shown that reduced fawn crops containing a preponderance of females are produced on over-browsed ranges where the animals suffer from malnutrition.

In general, therefore, it may be said that although winter food shortages may seriously effect the reproductive powers of some species, other forms are apparently not so influenced by such hardships.

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Shortages of high quality winter foods are also definitely known to effect the reproduction of whitetailed deer. Field studies conducted dur-



Figure 12. A second view of the pheasant in Figure 9.

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In general, therefore, it may be said that although winter food shortages may seriously effect the reproductive powers of some species, other forms are apparently not so influenced by such hardships.

Grit Requirements—The use of grit by birds of various species has long been a subject of interest. The literature on winter feeding contains many statements stressing the importance of supplying an abundance of grit with the grains fed. A reference of this type appeared in the Pennsylvania records over 16 years ago (Gordon, 1925), while the more recent publications carry similar instructions (Hicks, 1940; and Fox, 1941).

Though closely paralleling some of the work by other investigators, which is discussed in a subsequent section of this report, a series of grit requirement experiments was included in the studies under consideration. These were of two principal types. The first was designed to exemplify the previously established fact that many avian species can retain grit in the gizzard when the supply may for any reason be eliminated. The second was to test the ability of certain species to survive extended gritless periods.

In the retention experiments, slaughter methods were resorted to. Only two species were utilized, namely, the ringneck pheasant (*Phasianus colchicus torquatus*) and the bobwhite quail (*Colinus virginianus virginianus*). Thirty-five birds of each type were divided into experimental and control groups. The former contained in each case seven males and 14 females, while the latter were each comprised of 14 birds equally divided as to sex. Confined in floored pens in an unheated barn, where the environmental temperature ranged from 2° to 73°F., all birds were allowed to partake *ad libitum* of water, mash and dry scratch grains during the entire course of experimentation, which extended over a period of six weeks during February and March of 1940.

Following a one-week acclimation period, the grit was removed from the experimentals, though it remained constantly before the controls where it could be taken by them as desired. All specimens were weighed weekly, while three experimentals, including two females and one male, and one pair of controls were slaughtered at the same intervals. Immediately following death, the total amounts of grit in the crop and gizzard of each specimen were collected, dried and later weighed on a tested laboratory balance. With the data so obtained, it was felt that it would be possible both to check the "general physical condition" of the birds by study of their weight reactions and to determine their powers of grit retention by comparing the amounts of this material in the intestinal tracts.

In both experiments, it was realized that weight figures alone would not present entirely satisfactory information concerning the amount of grit in the intestinal tracts of the birds. In addition, both the numbers of grits and the volumes thereof are important. Since it appeared impractical to attempt to develop a single, mathematical combination accurately

descriptive of all three, it was thought that the reader could best visualize the results of the experiments if tables were prepared to show the weights both of the birds and the grits in their respective intestinal tracts, while photographs of the various collections of grits were also presented.

In studying both the pheasant and the quail statistics, the reader should not overlook the fact that the figures on average body weights are not all strictly comparable. In the first place, not only were there larger numbers of the experimental than of the control specimens, but also there were more of the smaller females among the former, while in addition, at the end of each weekly period three of the experimentals as compared to only two controls, were killed and autopsied. Secondly, due to the slaughter program, the earlier data were based on larger numbers of individuals than those secured toward the close of the experiment, with the result that the former were of greater accuracy than the latter since they reflected individual variations to a lesser degree.

Table XXI, page 74, contains a summary of the information gathered from the pheasant experiment, while a visual display of the grit collections removed from each specimen is to be found in Figure 13, page 76.

The figures presented in the table bring to light a number of interesting points. First, it may be seen that of the experimental birds, nine of which lived a month or more without access to grit other than that found in the intestinal tract, not a single individual perished except as the result of planned slaughter. Furthermore, study of the body weights of the individuals in both groups clearly shows that neither lot suffered other than normal losses, though in general the experimentals evidenced more favorable reactions than the controls. Most important is the fact that on the average the birds without access to grit contained in their intestinal tracts approximately the same amounts (actually slightly more by weight) of grit as did those which had the material constantly before them where it could be taken *ad libitum*. Though not necessarily of particular significance, it is interesting to note that experimental specimens numbers 54021, 54033 and 54030, which had been without external supplies of grit for six full weeks, contained in their crops and gizzards at the time of death weights of grit the average of which were in excess of those for all other slaughter groups, experimental or control, except numbers 54005 and 54011 killed on March 6. Furthermore, of the first-mentioned trio, two of the three exhibited gains in body weight during the period of experimentation.

Examination of the food consumption records reveals little of importance. Though it would appear as if ingestion by the experimentals was far less than by the controls, the differences, particularly during the closing weeks of experimentation, may well be largely individual.

TABLE XXI
GRIT RETENTION EXPERIMENT—RINGNECK PHEASANT
(*Phasianus colchicus torquatus*)
Type Stock: Artificially propagated, approximately 9 months of age.

Periods Ending (1940)	Feb. 7	Feb. 14	Feb. 21	Feb. 28	Mar. 6	Mar. 13	Mar. 20	Amount of Grit in Intestinal Tract A (Gms.)
Bodys Weights (Lbs.)—Experimental Group—No Grit After Feb. 5, 1940								
No. 54021 M	3.34	3.13	3.09	3.04	3.09	2.97	3.04 S	4.670
No. 54033 F	2.60	2.66	2.68	2.62	2.63	2.60	2.77 S	3.571
No. 54030 F	2.02	1.99	2.03	1.99	2.02	1.94	2.04 S	4.672
No. 54017 M	2.76	2.60	2.55	2.55	2.53	2.48 S		3.880 B
No. 54027 F	2.45	2.08	2.05	2.11	2.18	2.13 S		3.370
No. 54032 F	2.10	1.98	2.01	2.01	2.00	1.92 S		1.900
No. 54019 M	3.47	3.58	3.57	3.50	3.44 S			3.502
No. 54034 F	2.21	2.09	2.15	2.13	2.12 S			4.712 B
No. 54026 F	2.15	2.08	2.11	2.12	2.14 S			2.647
No. 54020 M	3.06	3.16	3.21	3.18 S				4.051
No. 54035 F	2.26	2.05	2.09	2.13 S				1.119
No. 54029 F	2.22	2.23	2.18	2.16 S				2.295
No. 54023 M	2.82	2.82	2.90 S					1.561
No. 54023 F	2.39	2.34	2.42 S					2.757
No. 54015 F	2.06	1.96	1.99 S					3.086
No. 54016 M	2.83	2.89 S						4.448
No. 54025 F	2.48	2.24 S						1.943
No. 54031 F	2.47	2.14 S						2.270
No. 54018 M	2.81 S							2.688
No. 54022 F	2.57 S							2.978
No. 54024 F	2.37 S							3.047
Average Per Bird	2.54	2.44	2.47	2.46	2.46	2.34	2.61	3.103
Average Chg. Per Bird	—	—0.10	+0.03	—0.01	0.0	—0.12	+0.27	—
Body Weights (Lbs.)—Control Group—With Grit Constantly								
No. 54002 M	3.44	3.10	3.05	3.16	3.13	3.07	3.27 S	3.942
No. 54014 F	2.49	2.15	2.18	2.14	2.12	2.05	2.16 S	0.343
No. 54007 M	2.49	2.65	2.65	2.72	2.77	2.63 S		2.820
No. 54010 F	2.60	2.26	2.30	2.33	2.29	2.15 S		2.518
No. 54005 M	3.29	3.01	3.00	3.04	3.02 S			3.500
No. 54011 F	2.28	2.05	2.06	2.10	2.08 S			6.120
No. 54033 M	2.85	2.85	2.90	2.87 S				4.090 B
No. 54009 F	2.17	1.92	2.09	2.03 S				1.052
No. 54001 M	2.79	2.79	2.77 S					3.974
No. 54008 F	2.04	1.86	1.85 S					3.350
No. 54006 M	2.81	2.90 S						2.951
No. 54013 F	2.80	2.25 S						1.706
No. 54004 M	3.14 S							2.397
No. 54012 F	2.65 S							4.041
Average Per Bird	2.70	2.48	2.49	2.54	2.57	2.47	2.71	3.057
Average Chg. Per Bird	—	—0.22	+0.01	+0.05	+0.03	—0.10	+0.24	—
Average Daily Food Consumption Per Bird								
Experimentals	29.8 gms.	29.9 gms.	35.9 gms.	31.5 gms.	40.6 gms.	40.2 gms.	43.4 gms.	—
Controls	31.0 gms.	32.3 gms.	36.6 gms.	39.1 gms.	46.3 gms.	52.0 gms.	52.8 gms.	—
Minimum and Maximum Environmental Temperatures								
Minimum	2° F.	19° F.	5° F.	5° F.	16° F.	9° F.	9° F.	—
Maximum	46° F.	73° F.	76° F.	67° F.	60° F.	47° F.	67° F.	—

Notes: All birds provided *ad libitum* and at all times with scratch grain, mash and water.
From January 30 until February 7, all birds provided with grit *ad libitum*, but no grit was provided experimental group after February 7.
A—Represents total weight of grit in crop and gizzard.
B—Lost leg band ingested and later included in tabulating weight of grit.
S—Indicates date on which bird was killed for autopsy.

The quail data are given in Table XXII, page 78, together with Figure 14, page 80.

In this case also the first point worthy of consideration is that none of the experimental birds perished other than by slaughter. Both the test and the control groups exhibited losses in body weight, though in no instance was the change of unusual significance. Finally, and most important, is the fact that in all apparent respects the amounts of grit in the intestinal tracts of the experimental quail compared quite favorably with those from the control specimens.

Certainly the two experiments above described establish beyond all question the previously stated fact that at least some species of birds are able in the absence of fresh supplies of grit to retain for comparatively long periods of time that which may already happen to be in the intestinal tract.

Possibly even more striking, however, is the fact that it was noted during the entire course of experimentation herein reported on, that without exception, birds which perished from starvation nonetheless retained in the gizzards at the time of death amounts of grit which might well be considered entirely comparable to those found in normal individuals. For example, two pheasants were subjected at 40°F. to fasts leading to fatal conclusions. One individual succumbed on the twenty-first and the other on the twenty-second day. In the gizzard of the former were 287 grits weighing 3.161 grams, while that of the latter contained 732 grits totaling 3.620 grams in weight. Similarly, a pair of Hungarian partridges perished on the sixth and eighth days as a result of forced fasting at 0°F. The gizzard of the first held 362 pieces of grit weighing 0.813 grams, while there were in the second 273 pieces totaling 0.841 grams in weight. The material taken from each of the four individuals is shown in Figure 15, page 82.

Pheasants and quail were also utilized in the second set of experiments designed to determine whether or not inability to obtain grit might tend over a long period of winter weather adversely to affect birds subsisting chiefly on weed seeds or waste grains. Ten ringnecks and 20 bobwhites were included in two similar experiments, wherein the effects of grit absence from the diet were determined by the body weight reactions of groups of birds with and without grit.

Starting on December 17, 1940, five female pheasants were cooped in a wire-bottomed, out-of-door pen with shelter, wherein water, mixed weed seeds and grit could be partaken of *ad libitum*. A second group of birds, comparable in every respect, was similarly confined and cared for except that grit was at no time or in no form available. At intervals over a period extending until February 25, 1941, a total of 70 days, records of

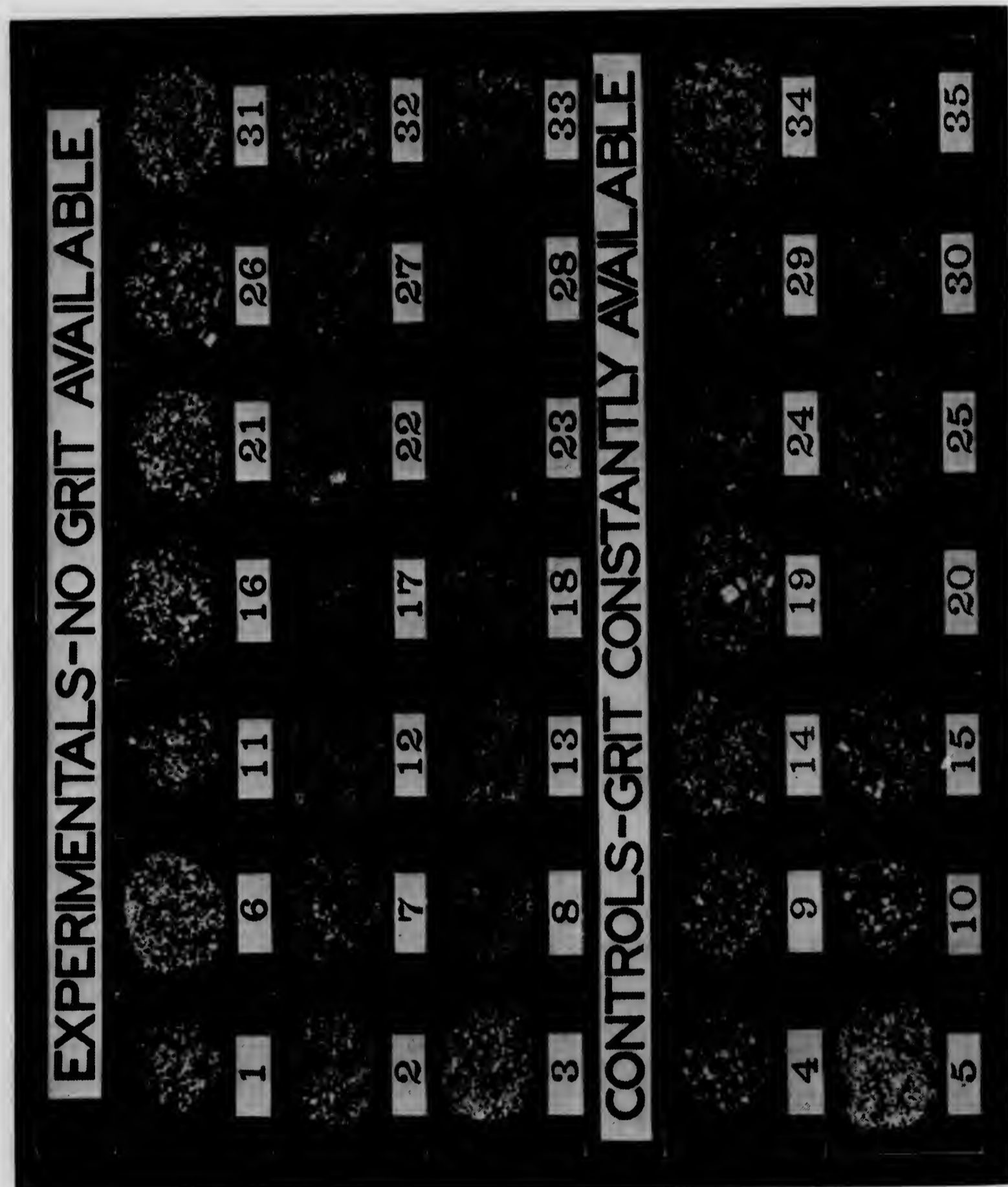


Figure 13. Grit removed from intestinal tracts of pheasants utilized in retention experiments.

EXPLANATION—FIGURE 13

Sq. No. 1.	Material from Experimental No. 54018 killed Feb. 7.	Weight—2.688 gms.
Sq. No. 2.	Material from Experimental No. 54022 killed Feb. 7.	Weight—2.978 gms.
Sq. No. 3.	Material from Experimental No. 54024 killed Feb. 7.	Weight—3.047 gms.
Sq. No. 4.	Material from Control No. 54004 killed Feb. 7.	Weight—2.397 gms.
Sq. No. 5.	Material from Control No. 54012 killed Feb. 7.	Weight—4.041 gms.
Sq. No. 6.	Material from Experimental No. 54016 killed Feb. 14.	Weight—4.448 gms.
Sq. No. 7.	Material from Experimental No. 54025 killed Feb. 14.	Weight—1.943 gms.
Sq. No. 8.	Material from Experimental No. 54031 killed Feb. 14.	Weight—2.270 gms.
Sq. No. 9.	Material from Control No. 54006 killed Feb. 14.	Weight—2.951 gms.
Sq. No. 10.	Material from Control No. 54013 killed Feb. 14.	Weight—1.706 gms.
Sq. No. 11.	Material from Experimental No. 54028 killed Feb. 21.	Weight—1.561 gms.
Sq. No. 12.	Material from Experimental No. 54023 killed Feb. 21.	Weight—2.757 gms.
Sq. No. 13.	Material from Experimental No. 54015 killed Feb. 21.	Weight—3.086 gms.
Sq. No. 14.	Material from Control No. 54001 killed Feb. 21.	Weight—3.974 gms.
Sq. No. 15.	Material from Control No. 54008 killed Feb. 21.	Weight—3.350 gms.
Sq. No. 16.	Material from Experimental No. 54020 killed Feb. 28.	Weight—4.051 gms.
Sq. No. 17.	Material from Experimental No. 54035 killed Feb. 28.	Weight—1.119 gms.
Sq. No. 18.	Material from Experimental No. 54029 killed Feb. 28.	Weight—2.295 gms.
Sq. No. 19.	Material from Control No. 54003 killed Feb. 28.	Weight—4.090 gms.
Sq. No. 20.	Material from Control No. 54009 killed Feb. 28.	Weight—1.052 gms.
Sq. No. 21.	Material from Experimental No. 54019 killed Mar. 6.	Weight—3.502 gms.
Sq. No. 22.	Material from Experimental No. 54034 killed Mar. 6.	Weight—4.712 gms.
Sq. No. 23.	Material from Experimental No. 54026 killed Mar. 6.	Weight—2.647 gms.
Sq. No. 24.	Material from Control No. 54005 killed Mar. 6.	Weight—3.500 gms.
Sq. No. 25.	Material from Control No. 54011 killed Mar. 6.	Weight—6.120 gms.
Sq. No. 26.	Material from Experimental No. 54017 killed Mar. 13.	Weight—3.880 gms.
Sq. No. 27.	Material from Experimental No. 54027 killed Mar. 13.	Weight—3.370 gms.
Sq. No. 28.	Material from Experimental No. 54032 killed Mar. 13.	Weight—1.900 gms.
Sq. No. 29.	Material from Control No. 54007 killed Mar. 13.	Weight—2.820 gms.
Sq. No. 30.	Material from Control No. 54010 killed Mar. 13.	Weight—2.518 gms.
Sq. No. 31.	Material from Experimental No. 54021 killed Mar. 20.	Weight—4.670 gms.
Sq. No. 32.	Material from Experimental No. 54033 killed Mar. 20.	Weight—3.571 gms.
Sq. No. 33.	Material from Experimental No. 54030 killed Mar. 20.	Weight—4.672 gms.
Sq. No. 34.	Material from Control No. 54002 killed Mar. 20.	Weight—3.942 gms.
Sq. No. 35.	Material from Control No. 54014 killed Mar. 20.	Weight—0.343 gms.

All squares 3" x 3". The finer grits are not all visible in photograph. Note ingested leg bands in Squares 19, 22 and 26. Also compare with Figures 14 and 15.

the body weights of all individuals were carefully tabulated. The resulting data are summarized in Table XXIII, page 83.

Though, as indicated, two of the experimental pheasants escaped while catching them for weighing, it is significant that three birds lived for 70 days and two others for 56 days without access to grit. Of even greater importance, however, is the fact that the former evidenced an average weight loss lower than that exhibited by the control specimens. Since the change in neither group was of significance, it appears as if the absence of grit from the diet caused the birds to suffer no serious ills.

Simultaneously conducted in exactly the same manner, except for the fact that larger numbers of birds of each sex were used in both the experimental and control groups, the quail experiment produced results practically identical with those obtained with the pheasant. These are listed in Table XXIV, page 84.

Here again, except for one individual which escaped on December 31, all the experimental birds, nine in number, successfully endured without apparent ill effects a 70-day period wherein no grit was provided. Furthermore, not only was the aggregate weight loss among the experimentals less than for the controls but also the losses of both groups were comparatively small for quail during the winter months.

Clearly the two experiments last described serve to show that pheasants and quail can subsist over long periods of time on weed seeds not accom-

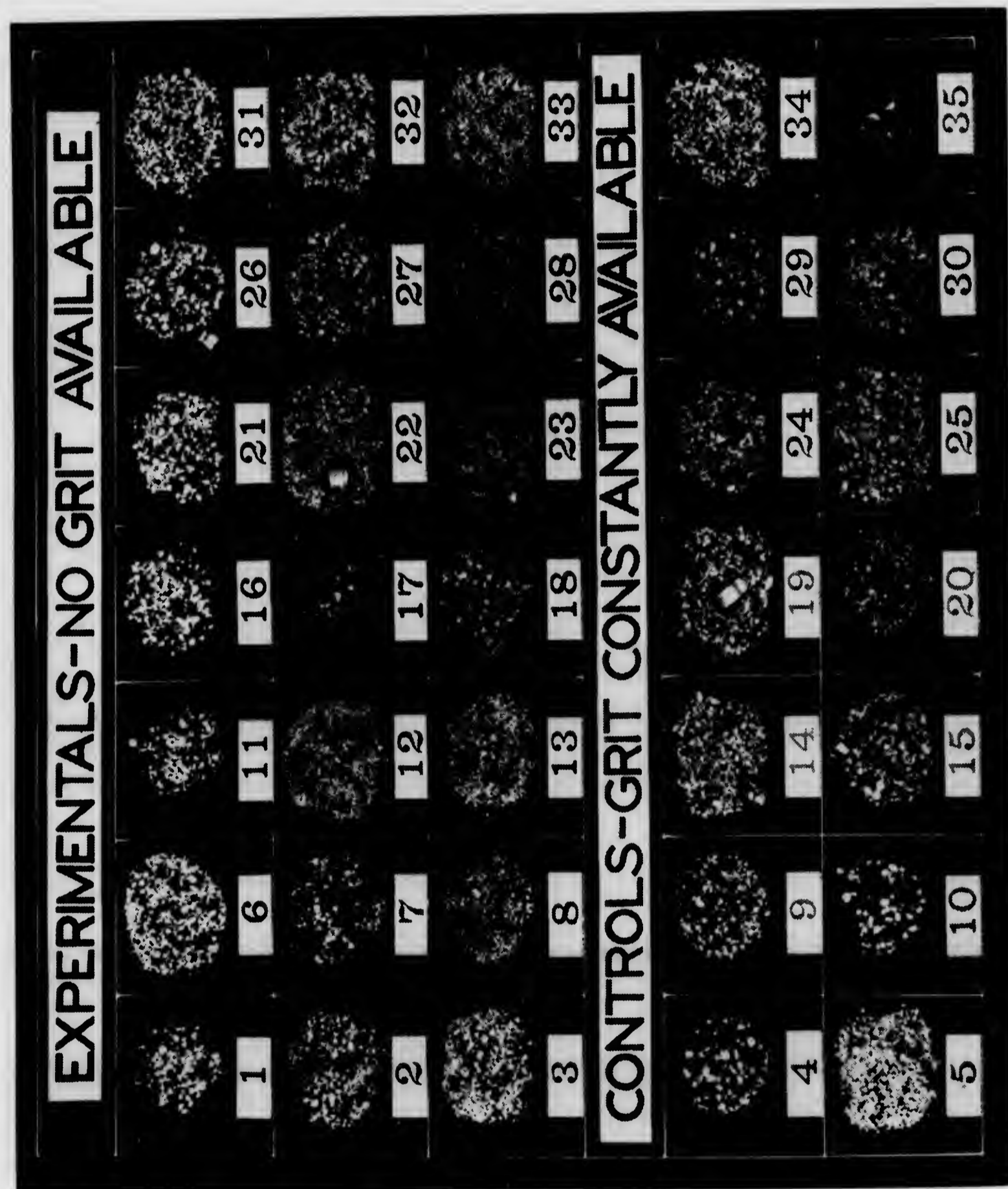


Figure 13. Grit removed from intestinal tracts of pheasants utilized in retention experiments.

EXPLANATION—FIGURE 13

Sq. No. 1.	Material from Experimental No. 54018 killed Feb. 7.	Weight—2.088 gms.
Sq. No. 2.	Material from Experimental No. 54022 killed Feb. 7.	Weight—2.978 gms.
Sq. No. 3.	Material from Experimental No. 54024 killed Feb. 7.	Weight—3.047 gms.
Sq. No. 4.	Material from Control No. 54004 killed Feb. 7.	Weight—2.397 gms.
Sq. No. 5.	Material from Control No. 54012 killed Feb. 7.	Weight—4.041 gms.
Sq. No. 6.	Material from Experimental No. 54016 killed Feb. 14.	Weight—4.448 gms.
Sq. No. 7.	Material from Experimental No. 54025 killed Feb. 14.	Weight—1.943 gms.
Sq. No. 8.	Material from Experimental No. 54031 killed Feb. 14.	Weight—2.270 gms.
Sq. No. 9.	Material from Control No. 54006 killed Feb. 14.	Weight—2.951 gms.
Sq. No. 10.	Material from Control No. 54013 killed Feb. 14.	Weight—1.706 gms.
Sq. No. 11.	Material from Experimental No. 54028 killed Feb. 21.	Weight—1.561 gms.
Sq. No. 12.	Material from Experimental No. 54023 killed Feb. 21.	Weight—2.757 gms.
Sq. No. 13.	Material from Experimental No. 54015 killed Feb. 21.	Weight—3.086 gms.
Sq. No. 14.	Material from Control No. 54001 killed Feb. 21.	Weight—3.974 gms.
Sq. No. 15.	Material from Control No. 54008 killed Feb. 21.	Weight—3.350 gms.
Sq. No. 16.	Material from Experimental No. 54020 killed Feb. 28.	Weight—1.051 gms.
Sq. No. 17.	Material from Experimental No. 54035 killed Feb. 28.	Weight—1.119 gms.
Sq. No. 18.	Material from Experimental No. 54029 killed Feb. 28.	Weight—2.295 gms.
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Sq. No. 22.	Material from Experimental No. 54034 killed Mar. 6.	Weight—4.712 gms.
Sq. No. 23.	Material from Experimental No. 54026 killed Mar. 6.	Weight—2.647 gms.
Sq. No. 24.	Material from Control No. 54005 killed Mar. 6.	Weight—3.500 gms.
Sq. No. 25.	Material from Control No. 54011 killed Mar. 6.	Weight—6.120 gms.
Sq. No. 26.	Material from Experimental No. 54017 killed Mar. 13.	Weight—3.880 gms.
Sq. No. 27.	Material from Experimental No. 54027 killed Mar. 13.	Weight—3.370 gms.
Sq. No. 28.	Material from Experimental No. 54032 killed Mar. 13.	Weight—1.900 gms.
Sq. No. 29.	Material from Control No. 54007 killed Mar. 13.	Weight—2.820 gms.
Sq. No. 30.	Material from Control No. 54010 killed Mar. 13.	Weight—2.518 gms.
Sq. No. 31.	Material from Experimental No. 54021 killed Mar. 20.	Weight—4.670 gms.
Sq. No. 32.	Material from Experimental No. 54033 killed Mar. 20.	Weight—3.571 gms.
Sq. No. 33.	Material from Experimental No. 54030 killed Mar. 20.	Weight—4.672 gms.
Sq. No. 34.	Material from Control No. 54002 killed Mar. 20.	Weight—3.942 gms.
Sq. No. 35.	Material from Control No. 54014 killed Mar. 20.	Weight—0.343 gms.

All squares 3" x 3". The finer grits are not all visible in photograph. Note ingested leg bands in Squares 19, 22 and 26. Also compare with Figures 14 and 15.

the body weights of all individuals were carefully tabulated. The resulting data are summarized in Table XXIII, page 83.

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Clearly the two experiments last described serve to show that pheasants and quail can subsist over long periods of time on weed seeds not accom-

TABLE XXII
GRIT RETENTION EXPERIMENT—BOBWHITE QUAIL
(*Colinus virginianus virginianus*)

Type Stock: Artificially propagated, approximately 9 months of age.

Periods Ending (1940) Body Weights — Ex- perimental Group— No Grit After Feb. 7	Feb. 9	Feb. 16	Feb. 23	Mar. 1	Mar. 8	Mar. 15	Mar. 22	Amount of Grit in Intestinal Tract A (Gms.)
No. 22614 F -----	174 g.	169 g.	169 g.	178 g.	173 g.	173 g.	173 g. S	0.522
No. 22608 F -----	191 g.	164 g.	164 g.	168 g.	166 g.	170 g.	165 g. S	0.147
No. 22625 M -----	177 g.	158 g.	160 g.	164 g.	161 g.	161 g.	158 g. S	0.305
No. 22611 F -----	213 g.	188 g.	183 g.	188 g.	183 g.	184 g. S		0.874
No. 22615 F -----	174 g.	163 g.	158 g.	168 g.	164 g.	152 g. S		0.224
No. 22622 M -----	172 g.	153 g.	151 g.	159 g.	154 g.	155 g. S		0.751
No. 22612 F -----	206 g.	183 g.	177 g.	180 g.	175 g. S			0.572
No. 22618 F -----	188 g.	177 g.	174 g.	180 g.	172 g. S			0.214
No. 22627 M -----	183 g.	157 g.	153 g.	162 g.	155 g. S			0.470
No. 22623 M -----	211 g.	173 g.	172 g.	181 g. S				0.332
No. 22609 F -----	197 g.	181 g.	175 g.	180 g. S				0.675
No. 22610 F -----	187 g.	177 g.	170 g.	173 g. S				0.365
No. 22613 F -----	199 g.	187 g.	109 g. S					0.479
No. 22626 M -----	224 g.	185 g.	185 g. S					0.498
No. 22617 F -----	167 g.	159 g.	161 g. S					0.603
No. 22620 F -----	194 g.	179 g. S						0.435
No. 22619 F -----	175 g.	169 g. S						0.298
No. 22628 M -----	196 g.	162 g. S						0.368
No. 22616 F -----	198 g. S							1.169
No. 22624 M -----	198 g. S							0.543
No. 22621 F -----	191 g. S							0.683
Average Per Bird -----	191.2 g.	171.3 g.	169.5 g.	173.4 g.	167.0 g.	165.8 g.	165.3 g.	0.501
Average Chg. Per Bird	—	-19.9 g.	-1.8 g.	+3.9 g.	-6.4 g.	-1.2 g.	-0.3 g.	—

Body Weights—Control Group—With Grit Constantly

No. 22631 F -----	208 g.	185 g.	180 g.	184 g.	177 g.	173 g.	174 g. S	0.345
No. 22636 M -----	176 g.	161 g.	163 g.	166 g.	163 g.	165 g.	164 g. S	0.145
No. 22630 F -----	212 g.	178 g.	184 g.	189 g.	187 g.	189 g. S		1.202
No. 22639 M -----	173 g.	158 g.	155 g.	158 g.	155 g.	156 g. S		0.528
No. 22634 F -----	209 g.	193 g.	188 g.	188 g.	180 g. S			1.175
No. 22640 M -----	180 g.	153 g.	153 g.	157 g.	143 g. S			0.277
No. 22638 M -----	167 g.	158 g.	158 g.	159 g. S				0.582
No. 22635 F -----	147 g.	145 g.	147 g.	149 g. S				1.572
No. 22642 M -----	182 g.	165 g.	163 g. S					0.435
No. 22632 F -----	173 g.	154 g.	155 g. S					0.413
No. 22641 M -----	187 g.	158 g. S						0.447
No. 22633 F -----	174 g.	155 g. S						0.550
No. 22629 F -----	210 g. S							0.142
No. 22637 M -----	180 g. S							0.538
Average Per Bird -----	184.1 g.	163.6 g.	164.6 g.	168.8 g.	167.5 g.	170.8 g.	169.0 g.	0.597
Average Chg. Per Bird	—	-20.5 g.	+1.0 g.	+4.2 g.	-1.3 g.	+3.3 g.	-1.8 g.	—

Average Daily Food Consumption Per Bird

Experimentals -----	10.5 g.	12.9 g.	13.5 g.	14.0 g.	15.3 g.	18.2 g.	16.4 g.	—
Controls -----	7.7 g.	13.7 g.	13.8 g.	13.2 g.	14.1 g.	16.9 g.	16.6 g.	—

Maximum and Minimum Environmental Temperatures

Minimum -----	2° F.	5° F.	5° F.	5° F.	29° F.	9° F.	9° F.	—
Maximum -----	49° F.	76° F.	72° F.	60° F.	42° F.	47° F.	67° F.	—

Notes: All birds provided *ad libitum* and at all times with scratch grain, mash and water.
From February 3 until February 9, all birds were provided with grit *ad libitum* but no grit was pro-
vided experimental group after February 9.
A—Represents total weight of grit in crop and gizzard.
S—Indicates date on which bird was killed for autopsy.

panied by renewed supplies of grit. Thus, it may in summary be stated that the ringneck pheasant and bobwhite quail, and probably many related species, are able in the absence of fresh supplies to retain previously ingested grit in the intestinal tract for periods of six weeks or more, while enforced abstinence from grit can be endured without serious ill effects for ten or more weeks of winter weather.

Water Requirements—Throughout numerous areas in the Northern United States and Southern Canada, varying in location during the passing years, comparatively long periods of days of unusual cold without previous or falling snows are not infrequent. These result in heavy freezing of practically every susceptible substance above the surface of the earth, including lakes, ponds, rivers, streams and swamps. Under extreme conditions it is practically impossible for birds and mammals to find any appreciable amounts of free water for drinking purposes.

During the existence of a combination of meteorological factors similar to that above described, a number of dead pheasants were found in several counties in North Central Pennsylvania during the winter of 1939-40. Though no specimens were submitted to laboratory examination, death was commonly attributed to lack of available drinking water. Partly to check this possibility and partly in search of information on the general subject, a number of winter water requirement experiments, involving several species of birds and mammals, were conducted. These are briefly described in the paragraphs immediately following.

Designed primarily to determine the ability of the various species to subsist during the winter months on dry foods, such as dog biscuits, grains and weed seeds, without drinking water, tests were run with ring-neck pheasants (*Phasianus colchicus torquatus*), bobwhite quail (*Colinus virginianus virginianus*), raccoons (*Procyon lotor lotor*) and skunks (*Mephitis nigra*). The general method of procedure was to divide the animals into experimental and control groups and to check the effects of the absence of drinking water as reflected in changes in the body weights of the two groups of individuals. With one exception specifically described, all experiments were conducted in pens located in an unheated barn, where temperature conditions were practically the same as out-of-doors. The work was performed during the months of December, January, February and March.

On December 18, 1940, 20 pheasants, including 10 males and 10 females, were divided into two groups. Both contained five specimens of each sex. All were allowed to feed *ad libitum* on dry scratch grain. The controls were constantly provided with drinking water, but none was at any time available to the experimental birds. The body weights of all individuals were recorded at intervals through March 7, 1941, a



Figure 11. Grit removed from intestinal tracts of bobwhite quail utilized in retention experiments.

EXPLANATION—FIGURE 14

Sq. No. 1.	Material from Experimental No. 22616 killed Feb. 9.	Weight—1.169 gms.
Sq. No. 2.	Material from Experimental No. 22624 killed Feb. 9.	Weight—0.543 gms.
Sq. No. 3.	Material from Experimental No. 22621 killed Feb. 9.	Weight—0.683 gms.
Sq. No. 4.	Material from Control No. 22629 killed Feb. 9.	Weight—0.142 gms.
Sq. No. 5.	Material from Control No. 22637 killed Feb. 9.	Weight—0.538 gms.
Sq. No. 6.	Material from Experimental No. 22620 killed Feb. 16.	Weight—0.435 gms.
Sq. No. 7.	Material from Experimental No. 22619 killed Feb. 16.	Weight—0.298 gms.
Sq. No. 8.	Material from Experimental No. 22628 killed Feb. 16.	Weight—0.368 gms.
Sq. No. 9.	Material from Control No. 22641 killed Feb. 16.	Weight—0.447 gms.
Sq. No. 10.	Material from Control No. 22633 killed Feb. 16.	Weight—0.550 gms.
Sq. No. 11.	Material from Experimental No. 22613 killed Feb. 23.	Weight—0.479 gms.
Sq. No. 12.	Material from Experimental No. 22626 killed Feb. 23.	Weight—0.498 gms.
Sq. No. 13.	Material from Experimental No. 22617 killed Feb. 23.	Weight—0.603 gms.
Sq. No. 14.	Material from Control No. 22642 killed Feb. 23.	Weight—0.435 gms.
Sq. No. 15.	Material from Control No. 22632 killed Feb. 23.	Weight—0.413 gms.
Sq. No. 16.	Material from Experimental No. 22623 killed Mar. 1.	Weight—0.332 gms.
Sq. No. 17.	Material from Experimental No. 22609 killed Mar. 1.	Weight—0.675 gms.
Sq. No. 18.	Material from Experimental No. 22610 killed Mar. 1.	Weight—0.365 gms.
Sq. No. 19.	Material from Control No. 22638 killed Mar. 1.	Weight—0.582 gms.
Sq. No. 20.	Material from Control No. 22635 killed Mar. 1.	Weight—1.572 gms.
Sq. No. 21.	Material from Experimental No. 22612 killed Mar. 8.	Weight—0.572 gms.
Sq. No. 22.	Material from Experimental No. 22618 killed Mar. 8.	Weight—0.214 gms.
Sq. No. 23.	Material from Experimental No. 22627 killed Mar. 8.	Weight—0.470 gms.
Sq. No. 24.	Material from Control No. 22634 killed Mar. 8.	Weight—1.175 gms.
Sq. No. 25.	Material from Control No. 22640 killed Mar. 8.	Weight—0.277 gms.
Sq. No. 26.	Material from Experimental No. 22611 killed Mar. 15.	Weight—0.874 gms.
Sq. No. 27.	Material from Experimental No. 22615 killed Mar. 15.	Weight—0.224 gms.
Sq. No. 28.	Material from Experimental No. 22622 killed Mar. 15.	Weight—0.751 gms.
Sq. No. 29.	Material from Control No. 22630 killed Mar. 15.	Weight—1.202 gms.
Sq. No. 30.	Material from Control No. 22639 killed Mar. 15.	Weight—0.528 gms.
Sq. No. 31.	Material from Experimental No. 22614 killed Mar. 22.	Weight—0.522 gms.
Sq. No. 32.	Material from Experimental No. 22608 killed Mar. 22.	Weight—0.147 gms.
Sq. No. 33.	Material from Experimental No. 22625 killed Mar. 22.	Weight—0.305 gms.
Sq. No. 34.	Material from Control No. 22631 killed Mar. 22.	Weight—0.345 gms.
Sq. No. 35.	Material from Control No. 22636 killed Mar. 22.	Weight—0.145 gms.

All squares 3" x 3". The finer grits are not all visible in the photograph. Compare with Figures 13 and 15.

total of 79 days. The data obtained are presented in Table XXV, page 85.

Examination of the statistics reveals the fact that all the experimental birds survived the test without benefit of drinking water. During the first three weeks of experimentation, ending on January 9, this group's average body weight, as well as those of all but two individuals, male number 54155 and female number 54156, evidenced a drop at each weighing period. In the aggregate, this amounted to slightly more than 15% of their total initial weight. Though the controls exhibited on January 9 an average loss of approximately 3% in body weight, there was not a uniform trend among the individuals or for the group, as both gains and losses were recorded at different times. Throughout the closing eight weeks, there was a tendency toward gradual increase in the weights of the experimental lot. This is reflected in both the average and individual statistics. At the conclusion of the test, the average figure was 93.7% of the initial total, representing a loss of only 6.3%. The individual figures ranged from a loss of 20.8% to a gain of 9.9%. During the same period, the control birds as a group showed no constant weight trend, though their total on March 7 was 105.0% of that for December 18, reflecting an average gain of 5.0%. The range among the individuals extended from a loss of 1.5% to a gain of 21.1%.

The data above presented serve definitely to establish the fact that during the winter months mature ringneck pheasants can subsist without

apparent ill effects on dry grains alone, including no drinking water or green foods of high water content.

In a second, similar experiment, a total of fifteen artificially propagated quail approximately 18 months of age was utilized. The experimental group was composed of five male and two female birds, while the control lot included five of the former and three of the latter sex. Table XXVI, page 86, summarizes the data secured from the test.

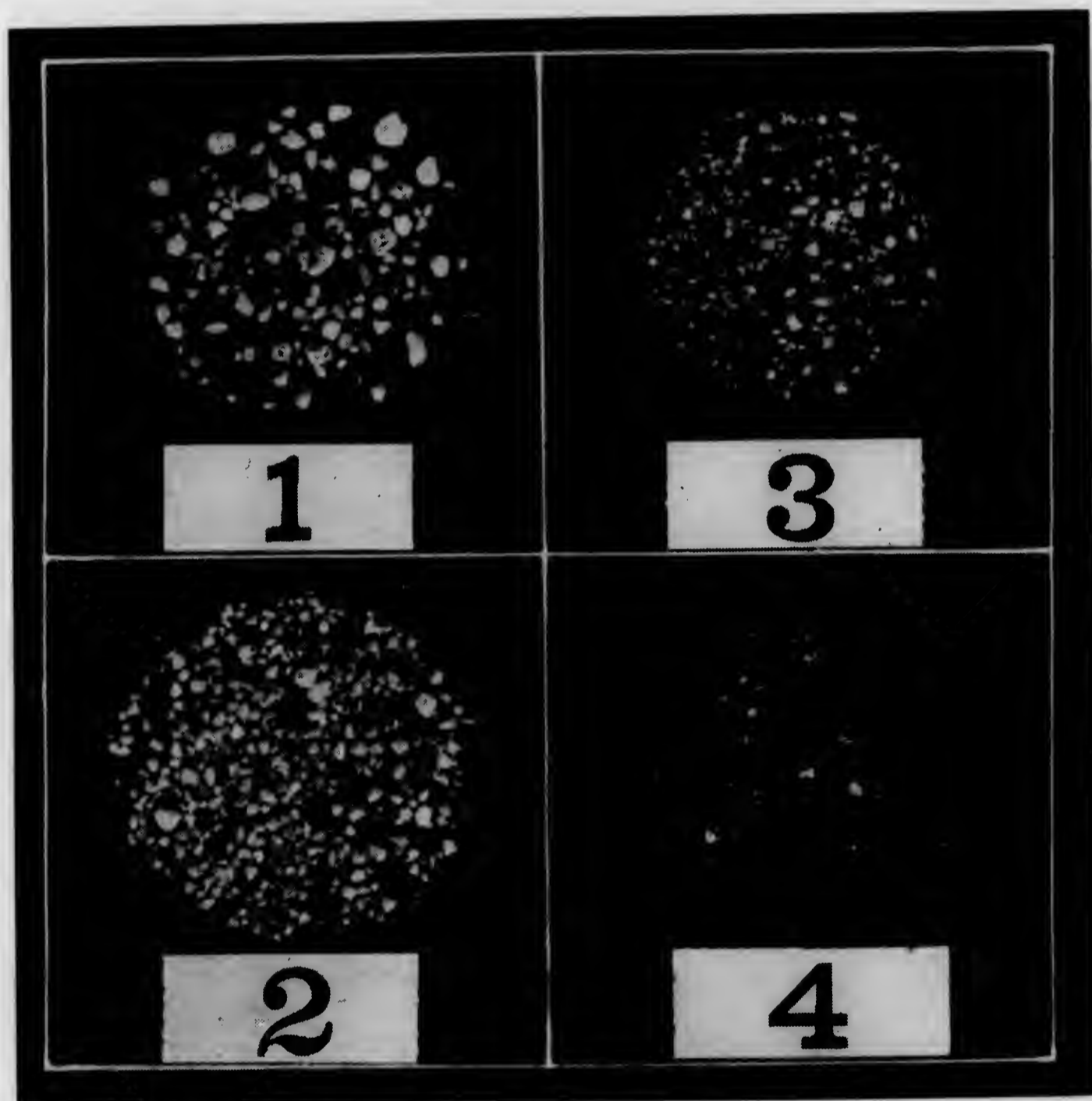


Figure 15. Grit retained in the gizzards of ringneck pheasants and Hungarian partridges fasted to fatal conclusions.

Even cursory examination of the figures reveals the fact that, unlike the ringneck, the bobwhite cannot live through the winter on dry grains alone without access to drinking water, snow, or succulent foods of high water content. During the first two weeks of experimentation, the average body weight of the test birds dropped roughly 17%, while the control specimens exhibited an average gain of approximately 11%. All individuals in the latter group added to their weights, but not a single

TABLE XXIII

GRIT REQUIREMENT EXPERIMENT—RINGNECK PHEASANT
(*Phasianus colchicus torquatus*)

Type Stock: Wild trapped, various ages with minimum of 18 months.

Number	Sex	Record of Body Weights								% Change in Weight
		Dec. 17, 1940	Dec. 31, 1940	Jan. 7, 1941	Jan. 14, 1941	Jan. 28, 1941	Feb. 11, 1941	Feb. 25, 1941		
Lot 1—Experimental Group—No Grit At Any Time Available										
1883	F	2.77 lbs.	2.34 lbs.	2.51 lbs.	2.39 lbs.	2.41 lbs.	2.30 lbs.	2.25 lbs.		—18.8%
1882	F	2.52 lbs.	2.22 lbs.	2.16 lbs.	2.23 lbs.	2.29 lbs.	2.30 lbs.	2.27 lbs.		—8.9%
54106	F	2.46 lbs.	2.04 lbs.	2.12 lbs.	2.23 lbs.	2.26 lbs.	2.30 lbs.	2.13 lbs.		—11.4%
54112	F	A	2.72 lbs. A	2.55 lbs.	2.45 lbs.	2.43 lbs.	2.48 lbs.	2.45 lbs.		—8.9% O
1909	F	B	2.38 lbs. B	2.18 lbs.	2.19 lbs.	2.23 lbs.	2.26 lbs.	2.13 lbs.		—10.5% C
Average -----	—	2.58 lbs. D	2.20 lbs. D	2.26 lbs. D	2.23 lbs. D	2.32 lbs. D	2.30 lbs. D	2.23 lbs. D		—13.5% D
Lot 2—Control Group—Grit Constantly Available										
54149	F	3.21 lbs.	2.85 lbs.	2.66 lbs.	2.56 lbs.	2.42 lbs.	2.39 lbs.	2.33 lbs.		—27.4%
1918	F	2.99 lbs.	2.69 lbs.	2.61 lbs.	2.55 lbs.	2.53 lbs.	2.58 lbs.	2.52 lbs.		—15.7%
1888	F	2.83 lbs.	2.48 lbs.	2.31 lbs.	2.32 lbs.	2.28 lbs.	2.32 lbs.	2.33 lbs.		—17.7%
54159	F	2.51 lbs.	2.16 lbs.	2.12 lbs.	2.15 lbs.	2.18 lbs.	2.16 lbs.	2.15 lbs.		—14.5%
1885	F	2.40 lbs.	2.20 lbs.	2.16 lbs.	2.16 lbs.	2.17 lbs.	2.24 lbs.	2.19 lbs.		—8.7%
Average -----	—	2.79 lbs.	2.48 lbs.	2.37 lbs.	2.35 lbs.	2.32 lbs.	2.34 lbs.	2.30 lbs.		—17.4%

Notes: All birds allowed to feed *ad libitum* on dry weed seeds.

All weight change figures cover period from Dec. 17 to Feb. 25 unless otherwise indicated.

A—No. 54114 originally placed in experiment escaped. Replaced Dec. 31 by No. 54112.

B—No. 1882 originally placed in experiment escaped. Replaced Dec. 31 by No. 1909.

C—Covers period from Dec. 31 to Feb. 25.

D—Figures relate only to 3 birds, Nos. 1883, 1882 and 54106, originally in experiment.

apparent ill effects on dry grains alone, including no drinking water or green foods of high water content.

In a second, similar experiment, a total of fifteen artificially propagated quail approximately 18 months of age was utilized. The experimental group was composed of five male and two female birds, while the control lot included five of the former and three of the latter sex. Table XXVI, page 86, summarizes the data secured from the test.

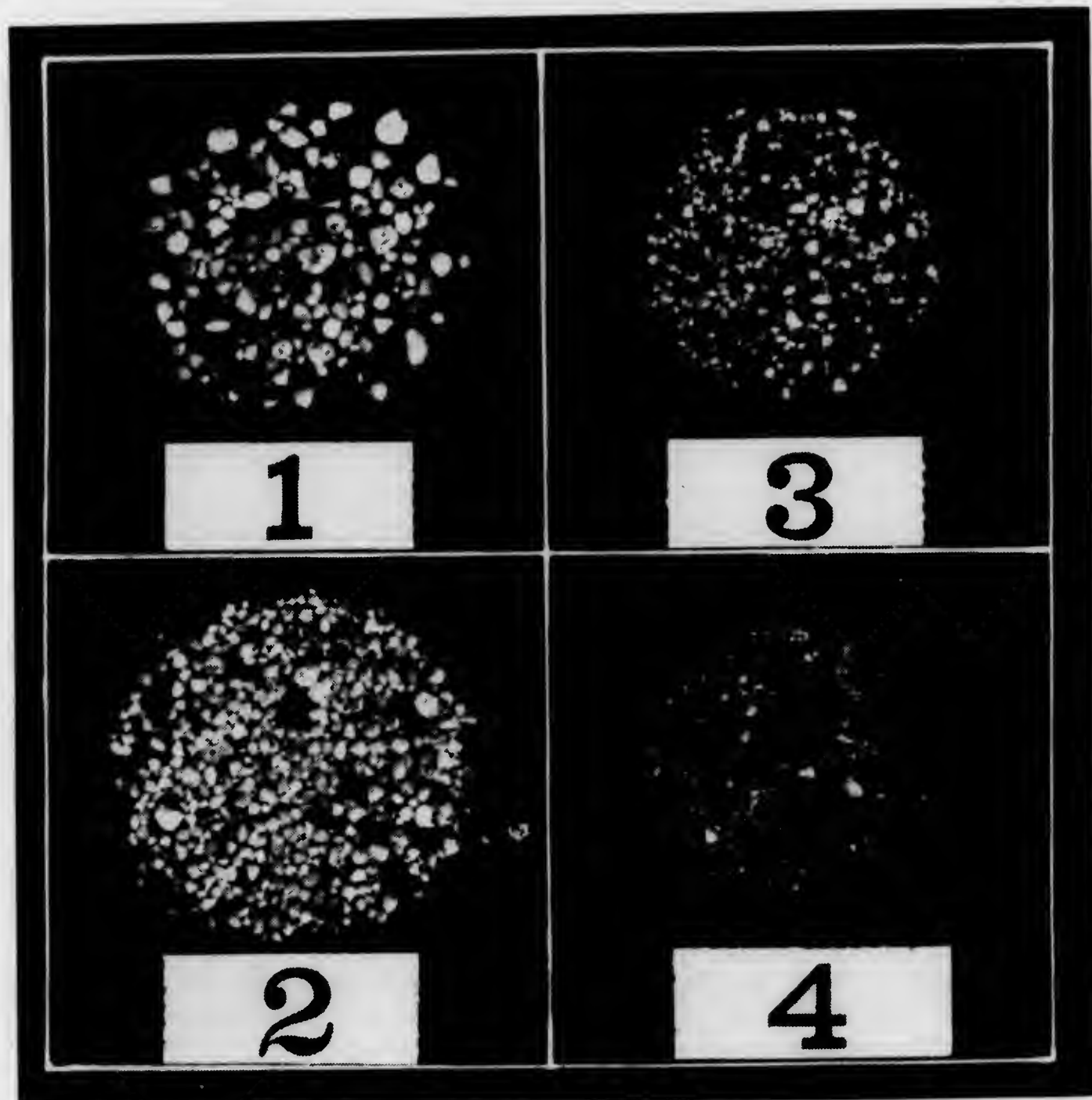


Figure 15. Grit retained in the gizzards of ringneck pheasants and Hungarian partridges fasted to fatal conclusions.

Even cursory examination of the figures reveals the fact that, unlike the ringneck, the bobwhite cannot live through the winter on dry grains alone without access to drinking water, snow, or succulent foods of high water content. During the first two weeks of experimentation, the average body weight of the test birds dropped roughly 17%, while the control specimens exhibited an average gain of approximately 11%. All individuals in the latter group added to their weights, but not a single

TABLE XXIII
GRIT REQUIREMENT EXPERIMENT—RINGNECK PHEASANT
(*Phasianus colchicus torquatus*)

Type Stock: Wild trapped, various ages with minimum of 18 months.

Number	Sex	Record of Body Weights							% Change in Weight
		Dec. 17, 1940	Dec. 31, 1940	Jan. 7, 1941	Jan. 14, 1941	Jan. 28, 1941	Feb. 11, 1941	Feb. 25, 1941	
Lot 1—Experimental Group—No Grit At Any Time Available									
1883	F	2.77 lbs.	2.34 lbs.	2.51 lbs.	2.39 lbs.	2.41 lbs.	2.30 lbs.	2.25 lbs.	-18.8%
1862	F	2.52 lbs.	2.22 lbs.	2.16 lbs.	2.23 lbs.	2.29 lbs.	2.30 lbs.	2.27 lbs.	-8.9%
54106	F	2.46 lbs.	2.04 lbs.	2.12 lbs.	2.23 lbs.	2.26 lbs.	2.30 lbs.	2.18 lbs.	-11.4%
54112	F	A	2.72 lbs. A	2.55 lbs.	2.45 lbs.	2.43 lbs.	2.48 lbs.	2.45 lbs.	-8.9% O
1909	F	B	2.38 lbs. B	2.18 lbs.	2.19 lbs.	2.28 lbs.	2.26 lbs.	2.13 lbs.	-10.5% C
Average -----	—	2.53 lbs. D	2.20 lbs. D	2.26 lbs. D	2.23 lbs. D	2.32 lbs. D	2.30 lbs. D	2.23 lbs. D	-13.5% D
Lot 2—Control Group—Grit Constantly Available									
54149	F	3.21 lbs.	2.85 lbs.	2.66 lbs.	2.56 lbs.	2.42 lbs.	2.39 lbs.	2.33 lbs.	-27.4%
1918	F	2.99 lbs.	2.69 lbs.	2.61 lbs.	2.55 lbs.	2.53 lbs.	2.58 lbs.	2.52 lbs.	-15.7%
1888	F	2.83 lbs.	2.48 lbs.	2.31 lbs.	2.32 lbs.	2.28 lbs.	2.32 lbs.	2.33 lbs.	-17.7%
54159	F	2.51 lbs.	2.16 lbs.	2.12 lbs.	2.15 lbs.	2.18 lbs.	2.16 lbs.	2.15 lbs.	-14.5%
1885	F	2.40 lbs.	2.20 lbs.	2.16 lbs.	2.16 lbs.	2.17 lbs.	2.24 lbs.	2.19 lbs.	-8.7%
Average -----	—	2.79 lbs.	2.48 lbs.	2.37 lbs.	2.35 lbs.	2.32 lbs.	2.34 lbs.	2.30 lbs.	-17.4%

Notes: All birds allowed to feed *ad libitum* on dry weed seeds.
All weight change figures cover period from Dec. 17 to Feb. 25 unless otherwise indicated.
A—No. 54114 originally placed in experiment escaped. Replaced Dec. 31 by No. 54112.
B—No. 1892 originally placed in experiment escaped. Replaced Dec. 31 by No. 1909.
C—Covers period from Dec. 31 to Feb. 25.
D—Figures relate only to 3 birds, Nos. 1883, 1862 and 54106, originally in experiment.

TABLE XXIV
GRIT REQUIREMENT EXPERIMENT—BOBWHITE QUAIL
(*Colinus virginianus virginianus*)
Type Stock: Artificially propagated, approximately 6 months of age.

Record of Body Weights									% Change in Weight
Number	Sex	Dec. 17, 1940	Dec. 31, 1940	Jan. 7, 1941	Jan. 14, 1941	Jan. 28, 1941	Feb. 11, 1941	Feb. 25, 1941	
Lot 1—Experimental Group—No Grit At Any Time Available									
22683	F	0.47 lbs.	0.44 lbs.	0.45 lbs.	0.47 lbs.	0.51 lbs.	0.46 lbs.	0.42 lbs.	—10.6%
22691	F	0.45 lbs.	0.43 lbs.	0.43 lbs.	0.43 lbs.	0.45 lbs.	0.46 lbs.	0.41 lbs.	—8.9%
22682	M	0.43 lbs.	0.41 lbs.	0.43 lbs.	0.45 lbs.	0.48 lbs.	0.46 lbs.	0.43 lbs.	0.0%
22684	F	0.42 lbs.	0.42 lbs.	0.40 lbs.	0.42 lbs.	0.45 lbs.	0.44 lbs.	0.41 lbs.	—2.4%
22657	M	0.41 lbs.	0.40 lbs.	0.40 lbs.	0.40 lbs.	0.42 lbs.	0.44 lbs.	0.38 lbs.	—7.9%
22685	M	0.40 lbs.	0.40 lbs.	0.40 lbs.	0.39 lbs.	0.43 lbs.	0.41 lbs.	0.38 lbs.	—5.0%
22692	M	0.39 lbs.	0.39 lbs.	0.38 lbs.	0.40 lbs.	0.41 lbs.	0.42 lbs.	0.38 lbs.	—2.6%
22687	F	0.39 lbs.	0.38 lbs.	0.37 lbs.	0.39 lbs.	0.41 lbs.	0.40 lbs.	0.36 lbs.	—7.3%
22686	F	0.37 lbs.	0.36 lbs.	0.36 lbs.	0.36 lbs.	0.38 lbs.	0.38 lbs.	0.35 lbs.	—5.4%
22660	F	0.37 lbs.	A						
Average -----	—	0.41 lbs.	0.40 lbs. B	0.40 lbs. B	0.41 lbs. B	0.44 lbs. B	0.43 lbs. B	0.39 lbs. B	—5.6% B
Lot 2—Control Group—Grit Constantly Available									
22671	F	0.44 lbs.	0.44 lbs.	0.44 lbs.	0.46 lbs.	0.48 lbs.	0.46 lbs.	0.41 lbs.	—6.8%
22652	M	0.43 lbs.	0.43 lbs.	0.41 lbs.	0.41 lbs.	0.44 lbs.	0.43 lbs.	0.40 lbs.	—7.0%
22653	M	0.42 lbs.	0.42 lbs.	0.41 lbs.	0.43 lbs.	0.46 lbs.	0.44 lbs.	0.45 lbs.	+7.1%
504	M	0.41 lbs.	0.42 lbs.	0.41 lbs.	0.43 lbs.	0.44 lbs.	0.43 lbs.	0.42 lbs.	+2.4%
22680	M	0.40 lbs.	0.40 lbs.	0.40 lbs.	0.43 lbs.	0.43 lbs.	0.43 lbs.	0.38 lbs.	—7.3%
22656	M	0.40 lbs.	0.41 lbs.	0.39 lbs.	0.40 lbs.	0.42 lbs.	0.43 lbs.	0.40 lbs.	0.0%
22664	F	0.40 lbs.	0.40 lbs.	0.36 lbs.	0.37 lbs.	0.37 lbs.	0.35 lbs.	0.29 lbs.	—27.5%
22663	F	0.39 lbs.	0.39 lbs.	0.38 lbs.	0.39 lbs.	0.40 lbs.	0.37 lbs.	0.33 lbs.	—15.4%
22689	F	0.39 lbs.	0.39 lbs.	0.37 lbs.	0.40 lbs.	0.41 lbs.	0.41 lbs.	0.38 lbs.	—2.6%
22655	M	0.36 lbs.	0.36 lbs.	0.34 lbs.	0.37 lbs.	0.38 lbs.	0.38 lbs.	0.36 lbs.	0.0%
Average -----	—	0.41 lbs.	0.41 lbs.	0.39 lbs.	0.41 lbs.	0.42 lbs.	0.41 lbs.	0.38 lbs.	—5.9%

Notes: All birds in both groups allowed to feed *ad libitum* on dry weed seeds.
All weight change figures cover period from Dec. 17 to Feb. 25.
A—No. 22660 escaped.
B—Figures based on 9 individuals, No. 22660 being excluded.

TABLE XXV
WATER REQUIREMENT EXPERIMENT—RINGNECK PHEASANT
(*Phasianus colchicus torquatus*)
Type Stock: Wild trapped, various ages with minimum of 17 months.

Record of Body Weights														% Change Weight Dec. 18 to Mar. 7
Number	Sex	Dec. 18, '40	Dec. 23, Jan. 2, '41	Jan. 9, '41	Jan. 16, '41	Jan. 32, '41	Jan. 30, '41	Feb. 2, '41	Feb. 13, '41	Feb. 20, '41	Feb. 28, '41	Mar. 7, '41		
Lot 1—Experimental Group—No Water Provided or At Any Time Available														
54146	M	2.66 lbs.	2.46 lbs.	2.45 lbs.	2.45 lbs.	2.48 lbs.	2.51 lbs.	2.62 lbs.	2.62 lbs.	2.65 lbs.	2.65 lbs.	2.65 lbs.	-0.4%	
54152	M	2.61 lbs.	2.31 lbs.	2.22 lbs.	2.11 lbs.	2.11 lbs.	2.11 lbs.	2.16 lbs.	2.23 lbs.	2.36 lbs.	2.43 lbs.	2.48 lbs.	-5.0%	
54154	M	2.55 lbs.	2.30 lbs.	2.24 lbs.	2.11 lbs.	2.01 lbs.	1.93 lbs.	1.92 lbs.	1.93 lbs.	2.02 lbs.	2.11 lbs.	2.19 lbs.	-14.1%	
54148	M	2.26 lbs.	1.95 lbs.	1.85 lbs.	1.78 lbs.	1.81 lbs.	1.80 lbs.	1.87 lbs.	2.00 lbs.	2.07 lbs.	2.16 lbs.	2.10 lbs.	-7.1%	
54155	M	2.11 lbs.	1.99 lbs.	1.94 lbs.	1.84 lbs.	1.84 lbs.	1.88 lbs.	2.00 lbs.	2.02 lbs.	2.11 lbs.	2.11 lbs.	2.11 lbs.	0.0%	
54153	F	2.02 lbs.	1.80 lbs.	1.72 lbs.	1.65 lbs.	1.71 lbs.	1.68 lbs.	1.63 lbs.	1.64 lbs.	1.66 lbs.	1.60 lbs.	1.60 lbs.	-20.8%	
54150	F	1.80 lbs.	1.65 lbs.	1.63 lbs.	1.60 lbs.	1.61 lbs.	1.61 lbs.	1.71 lbs.	1.69 lbs.	1.70 lbs.	1.69 lbs.	1.74 lbs.	-3.3%	
54156	F	1.71 lbs.	1.51 lbs.	1.52 lbs.	1.51 lbs.	1.51 lbs.	1.52 lbs.	1.54 lbs.	1.60 lbs.	1.45 lbs.	1.40 lbs.	1.45 lbs.	-15.2%	
54151	F	1.59 lbs.	1.40 lbs.	1.30 lbs.	1.31 lbs.	1.29 lbs.	1.34 lbs.	1.35 lbs.	1.38 lbs.	1.49 lbs.	1.53 lbs.	1.54 lbs.	-3.1%	
54147	F	1.41 lbs.	1.31 lbs.	1.29 lbs.	1.27 lbs.	1.33 lbs.	1.34 lbs.	1.41 lbs.	1.43 lbs.	1.49 lbs.	1.49 lbs.	1.55 lbs.	+9.9%	
Average	—	2.07 lbs.	1.87 lbs.	1.82 lbs.	1.77 lbs.	1.77 lbs.	1.78 lbs.	1.83 lbs.	1.84 lbs.	1.90 lbs.	1.92 lbs.	1.94 lbs.	-6.3%	
Lot 2—Control Group—Water Constantly Available														
54141	M	2.73 lbs.	2.72 lbs.	2.76 lbs.	2.65 lbs.	2.74 lbs.	2.70 lbs.	2.75 lbs.	2.69 lbs.	2.74 lbs.	2.78 lbs.	2.80 lbs.	+0.7%	
54142	M	2.78 lbs.	2.67 lbs.	2.76 lbs.	2.77 lbs.	2.75 lbs.	2.74 lbs.	2.71 lbs.	2.74 lbs.	2.80 lbs.	2.83 lbs.	2.90 lbs.	+4.3%	
54143	M	2.65 lbs.	2.53 lbs.	2.68 lbs.	2.55 lbs.	2.63 lbs.	2.58 lbs.	2.61 lbs.	2.54 lbs.	2.53 lbs.	2.53 lbs.	2.61 lbs.	-1.5%	
54139	M	2.27 lbs.	2.18 lbs.	2.31 lbs.	2.30 lbs.	2.37 lbs.	2.42 lbs.	2.51 lbs.	2.53 lbs.	2.54 lbs.	2.66 lbs.	2.75 lbs.	+21.1%	
54144	M	2.18 lbs.	2.15 lbs.	2.20 lbs.	2.14 lbs.	2.19 lbs.	2.19 lbs.	2.20 lbs.	2.12 lbs.	2.16 lbs.	2.21 lbs.	2.23 lbs.	+2.3%	
54137	F	2.03 lbs.	1.96 lbs.	2.01 lbs.	1.95 lbs.	2.03 lbs.	2.14 lbs.	1.91 lbs.	1.98 lbs.	1.98 lbs.	2.01 lbs.	2.13 lbs.	+4.9%	
54136	F	1.94 lbs.	1.85 lbs.	1.92 lbs.	1.92 lbs.	1.89 lbs.	1.93 lbs.	1.97 lbs.	1.92 lbs.	1.95 lbs.	1.90 lbs.	1.98 lbs.	+2.1%	
54138	F	1.57 lbs.	1.54 lbs.	1.60 lbs.	1.54 lbs.	1.52 lbs.	1.54 lbs.	1.56 lbs.	1.55 lbs.	1.55 lbs.	1.55 lbs.	1.57 lbs.	0.0%	
54145	F	1.48 lbs.	1.51 lbs.	1.56 lbs.	1.51 lbs.	1.58 lbs.	1.60 lbs.	1.61 lbs.	1.60 lbs.	1.58 lbs.	1.61 lbs.	1.68 lbs.	+13.5%	
54140	F	1.47 lbs.	1.41 lbs.	1.50 lbs.	1.46 lbs.	1.43 lbs.	1.46 lbs.	1.47 lbs.	1.46 lbs.	1.47 lbs.	1.51 lbs.	1.55 lbs.	+5.4%	
Average	—	2.12 lbs.	2.05 lbs.	2.13 lbs.	2.06 lbs.	2.12 lbs.	2.10 lbs.	2.13 lbs.	2.11 lbs.	2.13 lbs.	2.16 lbs.	2.22 lbs.	+5.0%	

Note: All birds in both groups allowed to feed *ad libitum* on dry scratch grain.

TABLE XXVI
WATER REQUIREMENT EXPERIMENT—BOBWHITE QUAIL
(*Colinus virginianus virginianus*)
Type Stock: Artificially propagated, 18 months of age.

Number	Sex	Record of Body Weights							Total Weight Change	
		Dec. 18, 1940	Dec. 26, 1940	Jan. 2, 1941	Jan. 9, 1941	Jan. 16, 1941	Jan. 23, 1941	Jan. 30, 1941		Feb. 6, 1941
		Lot 1—Experimental Group—No Water Provided or At Any Time Available								
22633	M	0.41 lbs.	0.32 lbs.	0.33 lbs.	0.28 lbs. A	0.29 lbs. B	—	—	—31.7%	
244	M	0.38 lbs.	0.34 lbs.	0.32 lbs.	0.31 lbs. C	—	—	—	—23.7%	
22696	M	0.37 lbs.	0.31 lbs.	0.32 lbs.	0.29 lbs. C	—	—	—	—21.6%	
22693	F	0.35 lbs.	0.31 lbs.	0.31 lbs.	0.27 lbs. C	0.25 lbs.	—	0.22 lbs. D	—37.1%	
22646	F	0.33 lbs.	0.28 lbs.	0.26 lbs.	0.21 lbs. E	—	—	—	—36.4%	
22647	M	0.32 lbs.	0.28 lbs.	0.30 lbs.	0.27 lbs. E	0.22 lbs. F	—	—	—31.2%	
22690	M	0.28 lbs.	0.21 lbs.	0.17 lbs.	0.17 lbs. G	—	—	—	—39.3%	
Average ----	—	0.35 lbs.	0.29 lbs.	0.29 lbs.	—	—	—	—	—	
Lot 2—Control Group—Water Constantly Available										
22699	M	0.45 lbs.	0.43 lbs.	0.47 lbs.	0.45 lbs.	0.45 lbs.	0.46 lbs.	0.46 lbs.	+4.4%	
22700	M	0.41 lbs.	0.41 lbs.	0.44 lbs.	0.42 lbs.	0.43 lbs.	0.42 lbs.	0.43 lbs.	+7.3%	
285	F	0.39 lbs.	0.39 lbs.	0.43 lbs.	0.40 lbs.	0.40 lbs.	0.41 lbs.	0.41 lbs.	+5.1%	
22698	M	0.38 lbs.	0.40 lbs.	0.44 lbs.	0.41 lbs.	0.41 lbs.	0.42 lbs.	0.42 lbs.	+10.5%	
22695	M	0.38 lbs.	0.37 lbs.	0.40 lbs.	0.38 lbs.	0.40 lbs.	0.39 lbs.	0.40 lbs.	+5.3%	
22697	M	0.37 lbs.	0.37 lbs.	0.40 lbs.	0.38 lbs.	0.37 lbs.	0.38 lbs.	0.37 lbs.	+2.7%	
22694	F	0.33 lbs.	0.33 lbs.	0.37 lbs.	0.36 lbs.	0.36 lbs.	0.36 lbs.	0.38 lbs.	+9.1%	
22629	F	0.31 lbs.	0.34 lbs.	0.38 lbs.	0.35 lbs.	0.36 lbs.	0.37 lbs.	0.36 lbs.	+16.1%	
Average ----	—	0.38 lbs.	0.38 lbs.	0.42 lbs.	0.39 lbs.	0.40 lbs.	0.40 lbs.	0.41 lbs.	+7.3%	

Notes: All birds in both groups allowed to feed *ad libitum* on dry scratch grains.
A—Represents weight of bird dead on January 7.
B—Represents weight of bird dead on January 21.
C—Represents weight of bird dead on January 15.
D—Represents weight of bird dead on January 30.
E—Represents weight of bird dead on January 7.
F—Represents weight of bird dead on January 17.
G—Represents weight of bird dead on January 3.
Total weight change represents that from December 18 until February 6, or until death.

Notes: All birds in both groups allowed to feed *ad libitum* on dry scratch grains.

- A—Represents weight of bird dead on January 7.
- B—Represents weight of bird dead on January 21.
- C—Represents weight of bird dead on January 15.
- D—Represents weight of bird dead on January 30.
- E—Represents weight of bird dead on January 7.
- F—Represents weight of bird dead on January 17.
- G—Represents weight of bird dead on January 3.

Total weight change represents that from December 18 until February 6, or until death.

test bird so reacted. Before the close of the third week, three of the experimental birds had perished. Two additional specimens died prior to the end of the fourth week; the sixth succumbed during the following week; while the seventh lived for six full weeks. The losses in weight up to the time of death ranged from 21.6% to 39.3%, with an average of 31.2%. On the other hand, all the control birds lived throughout the experiment, exhibiting weight gains ranging from 2.7% to 16.1%, with an average of 7.3%.

The results of the experiment clearly show that in this species subsistence during the winter months solely on dry grains, without access to drinking water, snow, or green foods of high water content, produces serious ill effects, usually followed by death within two to seven weeks.

A third water experiment involved four male and six female skunks of unknown ages. The experimental lot contained one of the former and four of the latter, while there were three males and two females in the check group. Table XXVII, page 88, sets forth the records gained.

Study of the chart indicates that, like the bobwhite, the skunk can subsist only for limited periods on dry food alone without drinking water. In this connection, however, it must be said the survival powers of the "polecat" are far greater than those of the quail. Throughout the entire course of the test, the rate of loss in body weight was appreciably higher among the experimental than the control specimens. The first experimental animal, number 2, perished during the eighth week of experimentation, while the second succumbed on the sixty-fourth day. At the close of the run on March 7, two additional skunks had succumbed, while only one remained alive. During the entire period, there were no losses among the control lot. In the aggregate, the weight losses, computed from the start of the experiment until its close, or until death, ran 35.5% for the test individuals as compared to only 16.1% for the controls. In this connection, it is significant to note that several of the animals had lost over two-thirds of their initial body weights prior to the time of death.

This test serves to show that under winter conditions, skunks can subsist from four to six weeks on dry foods alone without drinking water or foods of high water content, but that in so doing they suffer abnormal losses in body weight, while death may be expected at any time after the seventh week.

Only two raccoons were available of experimentation. Both were of the same sex, approximately nine months of age. Litter mates, they were born in the wild and captive reared.

Tested in the same general manner as the pheasants, quail and skunks, it was found that lack of drinking water among these water-loving animals

TABLE XXVII
WATER REQUIREMENT EXPERIMENT—SKUNK
(*Nephtis nigra*)

Type Stock: Wild caught, wild caught and captive reared, unknown ages.

Record of Body Weights												
Number	Sex	Lot 1—Experimental Group—No Water Provided or At Any Time Available										
		Dec. 18, '40	Dec. 26, '40	Jan. 2, '41	Jan. 9, '41	Jan. 16, '41	Jan. 32, '41	Jan. 30, '41	Feb. 6, '41	Feb. 13, '41	Feb. 20, '41	Mar. 7, '41
1	F	9.39 lbs.	7.95 lbs.	7.47 lbs.	7.18 lbs.	6.64 lbs.	6.30 lbs.	5.82 lbs.	5.47 lbs.	5.17 lbs.	4.87 lbs.	4.16 lbs.
2	F	6.26 lbs.	5.33 lbs.	4.80 lbs.	4.35 lbs.	3.78 lbs.	3.24 lbs.	2.83 lbs.	2.34 lbs.	2.08 lbs.	1.77 lbs.	1.93 lbs. B
3	M	6.00 lbs.	5.37 lbs.	4.96 lbs.	4.56 lbs.	4.30 lbs.	3.96 lbs.	3.68 lbs.	3.35 lbs.	3.03 lbs.	2.77 lbs.	2.31 lbs.
4	F	5.94 lbs.	5.76 lbs.	4.83 lbs.	4.32 lbs.	3.84 lbs.	3.41 lbs.	3.05 lbs.	2.67 lbs.	2.23 lbs.	1.91 lbs. C	1.75 lbs. D
5	F	5.78 lbs.	5.14 lbs.	4.73 lbs.	4.42 lbs.	4.07 lbs.	3.73 lbs.	3.44 lbs.	3.13 lbs.	2.80 lbs.	2.53 lbs.	—
Average	—	6.67 lbs.	5.91 lbs.	5.36 lbs.	4.97 lbs.	4.53 lbs.	4.13 lbs.	3.76 lbs.	3.39 lbs.	—	—	—
Total Weight Loss												
												—55.7%
												—66.8%
												—67.8%
												—67.8%
												—69.7%

Lot 2—Control Group—Water Constantly Available

Number	Sex	Lot 2—Control Group—Water Constantly Available										
		Dec. 18, '40	Dec. 26, '40	Jan. 2, '41	Jan. 9, '41	Jan. 16, '41	Jan. 32, '41	Jan. 30, '41	Feb. 6, '41	Feb. 13, '41	Feb. 20, '41	Mar. 7, '41
6	F	7.71 lbs.	7.44 lbs.	7.47 lbs.	7.24 lbs.	7.05 lbs.	6.97 lbs.	6.70 lbs.	6.54 lbs.	6.44 lbs.	6.14 lbs.	6.31 lbs.
7	M	5.95 lbs.	5.75 lbs.	5.37 lbs.	5.34 lbs.	5.04 lbs.	4.88 lbs.	4.86 lbs.	4.62 lbs.	4.68 lbs.	4.53 lbs.	4.54 lbs.
8	M	5.08 lbs.	5.11 lbs.	4.99 lbs.	4.87 lbs.	4.40 lbs.	5.00 lbs.	4.94 lbs.	4.96 lbs.	5.15 lbs.	4.98 lbs.	4.77 lbs.
9	F	4.98 lbs.	4.37 lbs.	4.77 lbs.	4.58 lbs.	4.40 lbs.	4.31 lbs.	4.03 lbs.	4.04 lbs.	4.04 lbs.	4.19 lbs.	3.89 lbs.
10	M	3.53 lbs.	3.55 lbs.	3.66 lbs.	3.53 lbs.	3.40 lbs.	3.39 lbs.	3.29 lbs.	3.23 lbs.	3.31 lbs.	3.39 lbs.	3.32 lbs.
Average	—	5.45 lbs.	5.24 lbs.	5.25 lbs.	5.11 lbs.	—	4.91 lbs.	4.76 lbs.	4.68 lbs.	4.72 lbs.	4.58 lbs.	4.57 lbs.
Total Weight Loss												
												—18.2%
												—23.7%
												—6.1%
												—21.9%
												—5.9%

Notes: All animals in both groups allowed to feed *ad libitum* on dry dog pellets.

A—Weight after death of animal on February 8.

B—Weight after death of animal on March 7.

C—Weight after death of animal on February 20.

D—Weight after death of animal on March 7.

E—Impossible to obtain accurate record with safety.

Total weight loss represents that from December 18 until March 7, or until death.

resulted in a rapid loss in body weight, culminating in death on the twenty-third day. The data are listed in Table XXVIII.

In view of the facts above outlined, it would appear that even during the winter months the raccoon requires drinking water in one form or another at comparatively short intervals.

Because of the somewhat surprising results obtained from the first pheasant experiment and because it was thought desirable to determine the effects of furnishing water to fasting individuals, a second water experiment was conducted with ringnecks in April and May of 1940. This was a laboratory study involving 12 individuals.

The birds, imported from England in late 1939, were artificially propagated individuals approximately 22 months of age. Divided into two groups of six each, one was used for experimental, the other for control

TABLE XXVIII
WATER REQUIREMENT EXPERIMENT—RACCOON
(*Procyon lotor lotor*)

Type Stock: Wild caught and captive reared, approximately 9 months of age.

Record of Body Weights						
Specimen Description	Dec. 17, 1940	Dec. 25, 1940	Jan. 2, 1941	Jan. 9, 1941	Jan. 16, 1941	% Change in Weight
No. 1—No water available	8.63 lbs.	6.39 lbs.	5.47 lbs.	5.08 lbs. D	—	—41.1%
No. 2—Water constantly available	7.07 lbs.	8.49 lbs.	8.54 lbs.	8.64 lbs.	8.23 lbs.	+16.4%

Notes:—Both animals males.

Both animals allowed to feed *ad libitum* on dry dog pellets.

D—Indicates dead animal.

Percent change in weight is from December 17 to January 16, or until death.

purposes. The former was without drinking water at all times, while the latter was constantly provided with it. In each lot, three birds were fasted at 0°F. and three under the previously described "standard conditions." A summary of the data is listed in Table XXIX, page 90.

In the case of the control specimens at 0°F., the periods of survival were 10, 12 and 14 days, averaging 12.0 days. The respective weight losses were 30.1%, 29.8% and 39.6%, with an average of 32.9%. The figures for the corresponding group of experimental birds in regard to survival were 8, 14 and 21 days, averaging 14.3 days. Their weight losses ran 27.2%, 33.8% and 32.5%, or an average of 31.4%. Though obvi-

TABLE XXIX

FASTING EXPERIMENT—RINGNECK PHEASANT

(Phasianus colchicus formosans)

Type Stock: Artificially propagated, approximately 20 months of age.

Date	Specimens With Water but Without Food						Specimens Without Water or Food					
	Env. Temp.—0° F. Air Mov.—0			Env. Temp.—34° to 55° F. Air Mov.—0			Env. Temp.—0° F. Air Mov.—0			Env. Temp.—34° to 55° F. Air Mov.—0		
	B. Wt. No. 1	B. Wt. No. 2	B. Wt. No. 3	B. Wt. No. 4	B. Wt. No. 5	B. Wt. No. 6	B. Wt. No. 7	B. Wt. No. 8	B. Wt. No. 9	B. Wt. No. 10	B. Wt. No. 11	B. Wt. No. 12
Apr. 12, 1940	3.09 lbs.	3.16 lbs.	2.75 lbs.	3.43 lbs.	2.97 lbs.	3.67 lbs.	3.01 lbs.	3.53 lbs.	3.57 lbs.	3.33 lbs.	3.19 lbs.	2.87 lbs.
Apr. 13, 1940	3.03 lbs.	3.09 lbs.	2.70 lbs.	3.34 lbs.	2.90 lbs.	3.60 lbs.	2.95 lbs.	3.45 lbs.	3.54 lbs.	3.25 lbs.	3.11 lbs.	2.82 lbs.
Apr. 14, 1940	2.98 lbs.	3.06 lbs.	2.65 lbs.	3.23 lbs.	2.89 lbs.	3.58 lbs.	2.90 lbs.	3.39 lbs.	3.49 lbs.	3.20 lbs.	3.03 lbs.	2.76 lbs.
Apr. 15, 1940	2.93 lbs.	2.99 lbs.	2.60 lbs.	3.23 lbs.	2.85 lbs.	3.49 lbs.	2.86 lbs.	3.34 lbs.	3.43 lbs.	3.12 lbs.	2.95 lbs.	2.70 lbs.
Apr. 16, 1940	2.86 lbs.	2.93 lbs.	2.55 lbs.	3.23 lbs.	2.80 lbs.	3.45 lbs.	2.76 lbs.	3.26 lbs.	3.39 lbs.	3.06 lbs.	2.89 lbs.	2.63 lbs.
Apr. 17, 1940	2.79 lbs.	2.87 lbs.	2.51 lbs.	3.18 lbs.	2.77 lbs.	3.40 lbs.	2.72 lbs.	3.19 lbs.	3.35 lbs.	3.05 lbs.	2.94 lbs.	2.59 lbs.
Apr. 18, 1940	2.73 lbs.	2.83 lbs.	2.47 lbs.	3.17 lbs.	2.75 lbs.	3.40 lbs.	2.60 lbs.	3.13 lbs.	3.30 lbs.	3.01 lbs.	2.85 lbs.	2.56 lbs.
Apr. 19, 1940	2.60 lbs.	2.76 lbs.	2.42 lbs.	3.11 lbs.	2.70 lbs.	3.32 lbs.	2.41 lbs.	3.03 lbs.	3.25 lbs.	2.94 lbs.	2.83 lbs.	2.52 lbs.
Apr. 20, 1940	2.48 lbs.	2.69 lbs.	2.34 lbs.	3.08 lbs.	2.68 lbs.	3.20 lbs.	2.19 lbs.	2.97 lbs.	3.21 lbs.	2.89 lbs.	2.79 lbs.	2.47 lbs.
Apr. 21, 1940	2.31 lbs.	2.62 lbs.	2.28 lbs.	3.05 lbs.	2.63 lbs.	3.23 lbs.	2.90 lbs.	2.90 lbs.	3.13 lbs.	2.84 lbs.	2.77 lbs.	2.40 lbs.
Apr. 22, 1940	2.16 lbs.	2.41 lbs.	2.20 lbs.	2.99 lbs.	2.54 lbs.	3.20 lbs.	2.85 lbs.	2.76 lbs.	3.04 lbs.	2.84 lbs.	2.73 lbs.	2.36 lbs.
Apr. 23, 1940		2.41 lbs.	2.09 lbs.	2.94 lbs.	2.60 lbs.	3.14 lbs.	2.67 lbs.	2.67 lbs.	2.98 lbs.	2.79 lbs.	2.69 lbs.	2.32 lbs.
Apr. 24, 1940		2.22 lbs.	1.93 lbs.	2.91 lbs.	2.57 lbs.	3.11 lbs.	2.54 lbs.	2.54 lbs.	2.93 lbs.	2.77 lbs.	2.66 lbs.	2.26 lbs.
Apr. 25, 1940			1.71 lbs.	2.89 lbs.	2.54 lbs.	3.07 lbs.	2.87 lbs.	2.87 lbs.	2.87 lbs.	2.74 lbs.	2.63 lbs.	2.20 lbs.
Apr. 26, 1940			1.66 lbs.	2.83 lbs.	2.51 lbs.	2.99 lbs.	2.85 lbs.	2.85 lbs.	2.79 lbs.	2.70 lbs.	2.60 lbs.	2.12 lbs.
Apr. 27, 1940				2.79 lbs.	2.45 lbs.	2.90 lbs.	2.70 lbs.	2.70 lbs.	2.74 lbs.	2.62 lbs.	2.57 lbs.	2.04 lbs.
Apr. 28, 1940				2.76 lbs.	2.43 lbs.	2.93 lbs.	2.69 lbs.	2.69 lbs.	2.74 lbs.	2.60 lbs.	2.52 lbs.	1.92 lbs.
Apr. 29, 1940				2.71 lbs.	2.39 lbs.	2.89 lbs.	2.64 lbs.	2.64 lbs.	2.69 lbs.	2.57 lbs.	2.46 lbs.	1.77 lbs.
Apr. 30, 1940				2.68 lbs.	2.35 lbs.	2.84 lbs.	2.60 lbs.	2.60 lbs.	2.69 lbs.	2.54 lbs.	2.39 lbs.	1.63 lbs.
May 1, 1940				2.60 lbs.	2.29 lbs.	2.78 lbs.	2.49 lbs.	2.49 lbs.	2.60 lbs.	2.49 lbs.	2.32 lbs.	1.50 lbs.
May 2, 1940					2.27 lbs.	2.72 lbs.	2.19 lbs.	2.19 lbs.	2.49 lbs.	2.41 lbs.	2.15 lbs.	1.37 lbs.
May 3, 1940					2.19 lbs.	2.57 lbs.			2.41 lbs.		2.03 lbs.	1.30 lbs.
May 4, 1940					2.10 lbs.	2.54 lbs.						

Notes: All birds males.

D—Indicates dead bird.

R—Indicates bird removed from chamber at point of death.

Percentages of initial weights lost up to time of death or removal from chamber: No. 1—30.1%, No. 2—29.8%, No. 3—39.6%, No. 4—24.2%, No. 5—29.3%, No. 6—30.8%, No. 7—27.2%, No. 8—33.8%, No. 9—32.5%, No. 10—21.9%, No. 11—36.4%, No. 12—54.7%.

ously slight, the differences here favor the birds without water, since their average survival period was longer and their average weight loss lower than for the control lot. Among the individuals fasted under the "standard conditions," the controls lived 19, 22 and 22 days, or an average of 21 days, while the corresponding figures for the experimentals were 17, 22 and 22 days, averaging 20.3 days. For the former, the weight losses were 24.2%, 29.3% and 30.8%, or an average of 28.1%, as compared to 21.9%, 36.4% and 54.7%, averaging 36.8%. Under these conditions, both sets of figures favor the birds with water. Considering both the experimental and control groups as units, the aggregate survival figures, were, respectively, 17.3 and 16.5 days, while the weight losses up to the time of death were 30.4% and 34.0%.

The experiment last described, together with that first discussed in this section, would seem to indicate that among all the environmental factors acting in opposition to the survival powers of the pheasant, lack of drinking water plays a decidedly minor role. Also, the results definitely establish the fact that at the lower environmental temperatures, such as those with which these researches are concerned, the fasting ability of the ringneck is not appreciably affected by the availability, or lack, of drinking water. Obviously, these two facts do not hold true among various other species.

Temperature and Air Movement—The fact that environmental temperatures play an important part in the winter survival of birds and mammals has long been recognized by practically all interested persons. The advocates of winter feeding stress the importance of furnishing game with supplemental foods during periods of extreme cold. Unfortunately, however, there is at hand comparatively little information concerning the relative effects of different degrees of cold upon our sporting birds and mammals.

Since certain of the fasting experiments previously described provide significant data on the subject at hand, the tests are briefly discussed from this aspect in the paragraphs immediately following.

Practically all the laboratory experiments involved a comparison of animals fasted at 0°F. with individuals held without food at temperatures ranging from 34° to 55°F. with a mean of approximately 40°F. Thus, study of the table which summarize the experiments reveals the effect of a temperature difference of approximately 40°F. on fasting birds and mammals. For convenience, a recapitulation of eleven representative runs is presented in Table XXX, page 92.

Examination of the chart shows that the average survival of eight avian and two mammalian species fasted under an approximate mean temperature of 40°F. with no air movement was just over nine days (about 216 hours). At 0°F., also without external nourishment and subject to no

TABLE XXX

SUMMARY OF LABORATORY FASTING EXPERIMENTS SHOWING EFFECTS OF AIR MOVEMENT AND TEMPERATURE

Animals Utilized			Environmental Temperature—0° F.				E. Temp.—34° to 55° F.			
Species	Type Stock	Age	Air Mov.—5.8 M.P.H.		Air Mov.—0.0 M.P.H.		Air Mov.—0.0 M.P.H.		Air Mov.—0.0 M.P.H.	
			No. Indiv.	Av. Surv.	No. Indiv.	Av. Surv.	No. Indiv.	Av. Surv.	No. Indiv.	Av. Surv.
Wild Turkey	Artificially propagated	9 months	2	8.00 days	2	13.50 days	2	15.50 days		
Ringneck Pheasant (A)	Artificially propagated	9 months	3	2.60 days	3	3.50 days	3	11.00 days		
Ruffed Grouse	Artificially propagated	Unknown	2	7.50 days	2	8.00 days	2	7.00 days		
Chukar Partridge	Artificially propagated	9 months	2	8.00 days	2	11.10 days	2	13.50 days		
Hungarian Partridge	Artificially propagated	9 months	2	5.50 days	2	7.00 days	2	12.50 days		
Bobwhite Quail	Artificially propagated	9 months	10	1.90 days	10	2.50 days	8	3.90 days		
Mallard Duck	Semi-domestic	Unknown	8	11.90 days	8	9.40 days	6	11.50 days		
Red-shouldered Hawk	Wild caught, captive reared	Unknown	1	6.00 days	1	12.00 days	1	12.00 days		
Ottontail Rabbit	Wild trapped	Unknown	5	1.75 days	5	2.50 days	4	5.75 days		
Muskrat	Wild trapped	Unknown	2	2.00 days	2	4.00 days	2	8.00 days		
Skunk	Wild caught, captive reared	Unknown	—	—	5	15.20 days	3	37.30 days		
Combined averages for all species			—	5.52 days	—	7.35 days B	—	9.07 days B		

Notes: All animals without food or water at all times.

A—Birds fasted 10 days under out-of-door conditions prior to inclusion in this test.

B—To provide strictly comparable figures, the skunk statistics, which included no test at air movement of 5.8 M.P.H., have been omitted in computing averages.

air movement, the corresponding figure was approximately seven and one-third days (roughly 176 hours), representing a decrease of approximately 19%.

This average, of course, does not hold for all species. For example, the grouse and hawk statistics show little or no significant differences at the two temperatures, while the data on muskrats and skunks (the latter not included in computation of table averages) show that survival at the lower temperature was only half of that at the higher zone. In these instances, however, the possible effects of individual variations among small numbers of experimental specimens must not be entirely disregarded.

Though its significance has been considered only by a few investigators, it appears that air movement, in the form of winds, may frequently play equally an important part in winter losses, or survival, as does environmental temperature. It was to check this supposition that the laboratory tests so frequently involved specimens fasting at 0°F. both with and without exposure to air movements of known velocities. The table just referred to also contains information on this particular subject.

In the experiments summarized, it was found that at 0°F. with a constant "wind" of 5.8 miles per hour, the average survival of 37 fasting individuals of the 10 species was 5.52 days (roughly 132 hours) as compared to 7.35 days (approximately 176 hours) for a like number of specimens of the same species at the same temperature but subject to no air movement. This represents a reduction of almost 25% in the survival period, which may be attributed to the effects of air movement.

Quite possibly the relative effect of air movement varies greatly at different temperatures, but it is obvious that the factor is one of major import.

PART III—DISCUSSION

A. Of the History and Status of the Practice

The basis which has allowed for the development of all winter feeding programs appears, as accurately as can be determined, to be comprised of two principal components. The first is an instinctive urge, common to a large percentage of the members of the human race, to provide wild animals observed during periods of severe weather with small bits of food. The second is a general, though inexplicable, belief that shootable game crops can annually be produced only through the provision of supplemental winter food supplies.

Throughout the Northern United States and Southern Canada, the history of winter feeding has followed the same general course. The primary steps have invariably centered around emergency feeding, involving merely the scattering of grains, or the use of crude shelters, only during periods of unusually severe weather. This is usually followed by a planned system, employing carefully constructed shelters constantly supplied with nutrients throughout the entire winter. The final phase embraces the food plot plan of feeding. Naturally, in many states and provinces, all three stages have been, or are being, simultaneously utilized.

Among the several states, Minnesota may possibly have reached the most advanced stage in the evolution of winter feeding programs. A recent report from there (Miller, 1938) stated that the goal of the game department's program was the complete elimination of the artificial feeding of the state's upland game birds. Under the plan being followed, seed is given farmers who leave a part of the crop shocked in the field over the winter. The report states that 3,984 acres were that year planted to black amber cane and 2,368 acres to millet.

As the years pass, more and more departments are centering their feeding efforts in activities such as those last described. Whether this represents the final stage in the development of winter game feeding programs, whether expansion and changes in methods are to follow, or whether the practice is destined to fade into a place of minor importance, only time will tell.

B. Of the Actual Need for Winter Feeding

In attempting to determine the true, or actual, need for winter feeding, two principal methods of investigation were followed. The first involved a study of the literature pertaining to winter losses of wildlife, while the second embraced a series of physiological experiments designed primarily to determine the relative ability of different species of birds and mammals to withstand unfavorable environmental extremes, particu-

larly low temperatures and shortages of food. A discussion of the results of each major phase of the research is presented in the paragraphs immediately following.

Of Past Records—The winter bird losses previously referred to (pages 14 to 21) deal with 32 game and over 40 other species. These range in size from wrens to geese. Prepared by more than 40 observers, the reports relate to deaths in 18 different states, or regions, of North America and the British Isles during 16 separate winters. The mammalian records (pages 21 to 23) are concerned with only six species of which three are considered as large and two as small game. Among moose, elk and deer, the losses usually continue in the same regions over a period of years.



Figure 16. Placing ear corn on the ends of sharpened twigs to provide food for wild turkeys.

Thus, though there are frequently many closely related publications dealing with different phases of the various "problems," only a limited number of the more important have been herein listed.

In considering the reported winter losses of wildlife as related to the need for furnishing supplemental feeds during the colder months, several important points must not be disregarded. First, there is the matter of regions, or localities, in which the losses have occurred. Particularly among the non-game birds, the greatest mortality has occurred in the

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In considering the reported winter losses of wildlife as related to the need for furnishing supplemental feeds during the colder months, several important points must not be disregarded. First, there is the matter of regions, or localities, in which the losses have occurred. Particularly among the non-game birds, the greatest mortality has occurred in the

Southern States where many species commonly winter, where environmental temperatures below the freezing point are encountered only at intervals of many years and where winter feeding is seldom, if ever, practiced. As examples, there are the bluebird losses of 1894-95 (Forbush, 1912), the destruction of thousands of sparrows, snowbirds, finches and cardinals in South Carolina in 1899 (Wayne, 1899; and Rice, 1924) and the decimation of tree swallows in Florida in February, 1940 (Christy, 1940; and Weber, 1940). Of the game species, only the woodcock and the dove have so suffered in the deep south (Forbush, *ibid.*; Wayne, *ibid.*; Rice, *ibid.*; and McIlhenny, 1940). On the other hand, practically all the winter losses of quail occur in the northern extremities of the species' range where winter feeding is commonly carried on (Kalbfus, 1919; Leopold, 1931, 1933 and 1937; Errington, 1931 and 1933; and Errington and Hamerstrom, 1936). Among ringneck-pheasants, the greatest mortality has been suffered in the prairie states where the meteorological factors are frequently extreme (Green and Beed, 1936; Beed, 1938; and Fried, 1940).

The second point of import is concerned with the percentages of the total populations represented by the individuals lost. Fortunately, these are in most instances comparatively small. For example, in the Ohio waterfowl losses of 1932 (Trautman, Bills and Wickliff, 1939) the mortality was believed to total "at least one thousand birds," while over 35,000 were estimated to be present in the area at the time. Certainly a reduction of less than 3% of a relatively small population portion remaining at the northern extremity of the normal winter range can hardly be expected to have far reaching results, though its very occurrence is in some respects admittedly to be regretted. Similarly, the large waterfowl losses in Idaho in 1937 involved hundreds, if not thousands, of individuals, but the percentage of the total resident population so destroyed was placed at less than 1% (Kalmbach and Coburn, 1937). In some instances, such as the longspur tragedy of 1904 (Roberts, 1907a), where the estimated losses have run into the millions, the percentage of the entire species population involved may be appreciable. Since most of the birds at any one time present in any portion of the southern, winter range, or at any point along the line of northward migration, where disaster may strike are believed to represent only the stock from a single portion of the breeding range (Griscom, 1941), even losses such as those of the longspur do not have consequences so dire that they may not usually be compensated for within the period of a comparatively few years either by "letting nature take its course" or by such methods as the restriction of hunting activities.

Finally, the cause of the catastrophes must be given due consideration. In some instances, exposure plays the major role as was the case of the

Iowa pheasants (Green and Beed, 1936; and Scott and Baskett, 1941). In others, such as the longspur (Roberts, *ibid.*) and bluebird (Forbush, *ibid.*) tragedies, severe storms are encountered by the migrating flocks. At times, starvation is the most important factor in mortality as among the South Dakota pheasants (Beed, 1938). In still other cases, including the waterfowl losses in Milwaukee Bay (Gromme, 1936) and quail in Iowa (Errington and Hamerstrom, 1936), the combined effects of cold and lack of food are the principal agents of destruction. Among the moose, elk and deer (Hickie, 1936; Rush, 1931; and Gerstell, 1937a) the lack of foods of proper quality results in slow, lingering deaths from malnutrition.

In conclusion it may be said that if the place of occurrence, the percentage of population involved and the cause of all reported losses be properly evaluated, it becomes immediately obvious that the recorded winter mortality of both game and non-game species presents no sound argument in favor of large-scale winter feeding operations.

Of Related Knowledge—Although, as previously pointed out (page 26), little or no basic research has been conducted with game birds and mammals as subjects, there exists nonetheless a wealth of pertinent facts derived from experimentation with other species. Because of their importance, it behooves every investigator in the wildlife field both to acquaint himself with the primary information so far disclosed and to utilize such knowledge in the interpretation of observations made or experimental results obtained.

For example, in connection with the fasting experiments herein reported on, merely to know that a given individual survived at a certain environmental temperature for a certain period of time and perished at a certain percentage of its initial body weight is indeed of limited value. If, however, it is realized that, in the main, the fasting ability of an animal depends upon its metabolic rate, which in turn is influenced by the internal factors of race, size, age and sex, together with the external factors of season, environmental temperature, humidity, air movement and light (see pages 26 to 28), it is possible accurately to evaluate the results of such an experiment, provided, of course, that the pertinent details are carefully listed.

It was, therefore, primarily to allow for comparison with man and the domestic animals and also to clarify the subject for readers to whom it may be foreign that the records of human and other fasts have been included (pages 24 to 26) and a discussion of factors affecting the ability to survive without food presented. It is hoped that this has served to render the report more intelligible for all.

Of the Fasting Experiments—The fasting experiments previously described (pages 31 to 63) involved a total of over 200 individuals of 15 separate species. Nine avian and six mammalian forms were included. The game species were nine in number, the predators and fur-bearers each three.

Among the game birds, the pheasant was found to be best able to withstand the effects of fasting under all conditions utilized in the tests. In out-of-door experiments conducted during mid-winter, survival without food was seldom less than 10 days, while over half of a group of 25 females survived a complete fast of 35 days' duration. Even after a period of 10 days without nourishment, temperatures of 0°F. were endured for several days by birds of this type. The wild turkey also proved to be a comparatively hardy species. Under even the most severe trials (0° with air movement in excess of 5 m.p.h.), survival was a week or more. This information, together with the comparative paucity of recorded losses from starvation throughout even the northern portions of the species' range, would seem clearly to indicate that there is no need to furnish birds of these types with supplemental food supplies during the winter months in order to enable them to carry through.

Though greatly at variance with the results obtained with other forms, in that low environmental temperatures and air movement did not greatly reduce the period of survival among the few birds tested, the ruffed grouse was also found to be capable of withstanding a week or more of fasting under extreme conditions. In view of this, together with the fact that the species' natural range extends far northward on the continent with few, if any, records of starvation losses, here again there would appear to be little or no need for winter feeding.

The Hungarian, or European grey, and the chukar partridges fall into an intermediate classification. The laboratory experiments performed with the former indicate that it can survive extreme conditions without food for less than a week. At the same time, however, starvation has not been recorded as an important factor in winter mortality among the species. In fact, a recent study of North Dakota not only showed by a comparison of "fed" and "unfed" covies that artificial feeding was not necessary to high winter survival, but also failed to reveal any losses from starvation or malnutrition (Hammond, 1941). The fasting experiments showed the chukar to be more resistant to lack of food than the "Hun." The indications are that it can readily withstand without nourishment a week of winter weather. Thus, though little is known of this exotic's ability to perpetuate its kind under North American conditions, it nonetheless appears that neither it nor the grey partridge require artificial feeding during the winter months.

The mallard duck, being a migratory species, is representative of another large and important group of game birds. The tests performed with the bird show that its powers of resistance to unfavorable conditions are indeed high. That it is apparently able to withstand environmental temperatures of 0°F. possibly even more readily than those ranging from 35° to 45°F. is of especial interest. Obviously not subject to heavy winter losses resulting from food shortages and normally wintering primarily in southern climes, the mallard could doubtless benefit little, if at all, from most winter feeding programs.



Figure 17. Hungarian partridges leaving a shelter constructed of corn fodder.

In the game bird list, the bobwhite quail stands near the bottom as far as ability to withstand lack of food is concerned. In the fasting series, the maximum survival was less than one week even at the higher temperatures, while in the lower zones it averaged only several days. In this connection, it must be remembered that both observations in the field and tests performed in the laboratory have revealed the fact that even under favorable food conditions the bobwhite suffers severe mortality as a result of exposure to environmental extremes. Thus, though constant ability to secure foods of high nutritive value is essential to the well-being

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of the quail during the winter months, the conduction of winter feeding programs does not necessarily guarantee high survival because of the extreme effects of exposure.

As might be expected, the avian predators studied, the great horned owl and the red-shouldered hawk, both exhibited high powers of resistance to starvation even under environmental extremes. This undoubtedly accounts for the fact that few, if any, winter losses have been recorded for the two birds.

Of the various species of mammalian game, only two were included in the fasting tests, namely, the deer and the cottontail rabbit. Both these forms are in a somewhat peculiar position in that readily eaten foods are available to them at practically all times. For example, unusually deep snows render the natural foods of some birds and mammals almost unobtainable. In the case of the deer, however, the deeper the snow the higher are the animals able to reach for browse, though their ability to travel in search of food may under such conditions be so limited as to offset any advantage gained by their increased reach. Likewise, deep snow may also enable the rabbit to reach low-hanging twig and branch tips otherwise unobtainable, while it has little or no adverse effects on the availability of plant stems from which nourishment may be gathered by "barking."

In view of the facts above mentioned, it is interesting to note that the fasting powers of the deer are relatively high, while those of the rabbit are comparatively low. Serious losses from starvation are reported for neither animal, though the former suffers heavy mortality on the over-browsed ranges, while the latter possibly is reduced in numbers by exposure on areas lacking in cover, particularly in the form of burrows. Apparently, neither benefits appreciably from winter feeding, while in the case of the deer, emergency feeding frequently produces ill effects of no small consequence, as will later be described.

The grey fox was the only mammalian predator studied. The average period of survival for two specimens, one at 0°F. and the other at approximately 40°F., was roughly 10 days, the specimen held at zero perishing toward the close of the seventh day, the other after nearly 13 days. Certainly this is a hardy species among which losses from starvation are rarely, if ever, to be expected.

Of the three fur-bearing animals studied, the muskrat represents a form particularly low in powers of resistance, the opossum an intermediate class and the skunk an unusually vigorous species. Without benefit either of food or the protection of its house, or burrow, the rat is obviously incapable of long resisting meteorological extremes. Unless

deprived by some means of its home, however, it would appear that this species can well endure the extremes of winter, though loss of that protection provided by reed shelter or den probably means death during severe cold, regardless of food conditions. Mortality among opossums probably is insignificant even under extreme conditions. Winter losses from starvation can hardly be expected for the skunk which normally lives in an even-temperated burrow, but which exhibited an average survival of over 15 days at 0°F. and over 37 days at 40°F. Surely there is nothing to be gained by the winter feeding of these animals.

In summary, it may be said that of the 15 species studied, only one, the bobwhite quail, is highly susceptible to starvation as well as exposure. Two others, the cottontail rabbit and the muskrat, may, particularly in the absence of food, fall victim to exposure quite rapidly if proper protective cover is not available. The remainder appear capable of enduring without serious hardship a week or more of severe winter weather without benefit of nourishment from sources outside the animal body. Such findings are in accordance with the recorded losses for the various species. These indicate that in the Northern United States and Southern Canada, except where over-browsing of the range has brought about heavy mortality among moose, elk and deer solely as a result of malnutrition, the bobwhite quail is the only species suffering heavy winter losses.

Of Effects of Fasting on Fecundity—The relationship between winter food shortages and fecundity is not only of particular interest but also of signal import. As previously pointed out, the proponents of winter feeding stress the point that birds and mammals "must be carried through the winter in good condition in order to breed the following spring." Certainly their stand is open to question.

In the first place, the normal mating season for some animals, such as the skunk, coincides with a period in which they are very definitely not "in their prime." The "polecat" normally mates in late February and March, though investigators in both New York (Hamilton, 1937) and Pennsylvania (Grimm, 1941) have revealed the fact that skunks normally "fall off" appreciably in weight between late fall or early winter and late winter or early spring. In other words, the animals copulate during a period when they are, in the layman's terminology, not in "the best of condition." In this case it is, of course, true that as pregnancy progresses, general food conditions tend to become more favorable. On the other hand, in the Northern United States and Southern Canada, the mating season for the white-tailed deer normally occurs in late October and early November when both bucks and does are in their "best physical condition." This means, however, that these animals, known to

reach the minimum point in their weight curve during late February, March, or early April depending upon climatic conditions (Gerstell, 1937a), are roughly in the middle of the pregnancy period when in their "poorest condition." In the case of the pheasant, mating and egg laying normally occurs during April when the birds are not at "the peak of condition," though there is usually a simultaneous improvement in food conditions brought about by the appearance of numerous green plants just at this time. Finally, many of the avian forms mate and nest almost immediately following the wearing (?) effects of a long, northward migration. In summary, therefore, it would appear that in a large percentage of the birds and mammals, the normal breeding phenomena occur during periods where the animals are not in what might be generally termed "particularly good condition."

It is, of course, known that periods of extreme cold, or food shortages, or a combination of the two may at times delay the breeding activities of various species, particularly the avian forms. Such tendencies are born out by the fasting-fecundity tests previously described (page 63), as well as innumerable ornithological records. In the case of the ground-nesting game birds, delayed breeding may lead either to favorable or unfavorable results, though the latter are possibly the more frequent. With many species, such as the pheasant, a delay in egg laying may allow for the selection of nesting sites better protected from predators or other agencies of destruction than those available during the normal period. This, of course, would be the result of the advanced stages of cover development encountered as the season advances. On the other hand, it is often true with the ringneck that only the early nests escape destruction during the first hay mowing operations. Similarly, late-nesting ducks frequently suffer decreased nest disturbances due to better cover conditions, though late-hatched ducklings often encounter severe drought not common to the fore-part of the season. The important point is that there is little or no evidence that those factors inducing delayed migration and nesting also result in decreased fecundity. In fact, there is available certain information which seems to indicate that delayed breeding in birds (which must not be confused with re-nesting activities) is definitely not accompanied by lowered reproductive powers. For example, though the spring migration, and hence the breeding activities, of many species of passerine birds common to the New England States was greatly delayed as a result of the severe weather in the Southern States during the winter of 1939-40, there was no decrease in the reproductive activities of those individuals returning to the breeding grounds (Griscom, 1941).

In the case of deer, investigations conducted by the writer (Gerstell, 1940) indicate that unfavorable range conditions at times result in a

reduced rate of herd reproduction, together with the occurrence of a preponderance of females among the offspring. The former appears to be due at least in part to resorption of a number of embryos in late winter and early spring when food conditions are least favorable. This has been observed only in the case of does carrying two or more foeti. Among the wild animals, the same phenomenon has also been noted in the skunk (Allen, 1939; and Wight, *in litt.* Oct. 30, 1940). Similarly, it is commonly said that the snowy owl breeds only to a limited extent during those seasons wherein lemmings are unusually scarce. Conversely, it has been reported (McWilliam, 1941) that following those seasons when voles are particularly numerous in England, short-eared owl nests containing ten, twelve or even more eggs have been found.

It is the writer's belief that in cases such as those just described, the principal factor is not that of mere abundance of food, but rather of food quality. For example, since "starved" deer are known to die with full stomachs as heretofore pointed out, it appears obvious that the problem is not one of lack of food but rather of food type. The animals actually die of malnutrition resulting from forced subsistence on nutrients of low value. Also, in the case of the English short-eared owl, it has been pointed out (McWilliam, *ibid.*) that the species is resident where voles are not found, but that breeding occurs only in vole territory. Certainly this would represent an effect of quality rather than quantity of food and animal "condition."

The points just mentioned, together with the experimental evidence previously presented, would seem to indicate that "carrying animals through the winter in good condition" is not so all-important as many believe. According to the evidence at hand, it would appear that most species of birds and mammals can undergo during the winter months appreciable losses in body weight, representing "poor condition," without suffering reduced reproductive powers, provided that the essential vitamins and other factors of quality, as compared to quantity, are present in the available foods.

Since so little is known about the nutritional requirements of wild game, it is entirely conceivable that the winter food mixtures commonly supplied in the feeding programs lack certain of the biochemical essentials of the various species. Thus, though they might help to keep certain individuals "in good condition," they also might have little or no effect on breeding power. On the other hand, the experimental data obtained from the pheasant experiment (page 63) would seem to indicate that birds "in exceptionally good condition" may frequently suffer delayed breeding as a result of the carriage of excess fat. Possibly complete dependence upon artificial food supplies might result in situations of this

type. To say the least, it would certainly appear as if many artificially propagated pheasants are entirely "too fat" at the time of release in the spring of the year. This is believed frequently to result in abnormally late and low reproduction during the season immediately following their planting.

Of Necessity for Grit—For several hundred years, the physiology of the avian gizzard, particularly among domestic fowls, has been the subject of intensive study. The consensus of opinion seems to be that its primary function is that of a grinding organ. A summary of the knowledge of such action appeared a few years ago (Henry, Macdonald and Magee, 1933), while more recent experiments, made possible by the development of a technique for removing the gizzard from domestic fowls (Burrows, 1936), have confirmed the belief by showing that birds without gizzards are perfectly capable of normal digestion of finely ground feeds (Fritz, Burrows and Titus, 1935). Also, during the past several years, gizzardectomized fowls, which behave normally even to the extent of egg laying, have been used by several commercial firms for advertising purposes. Such facts definitely show that the gizzard is not essential to avian life.

The function and utilization of grit (most frequently observed only in the gizzard) also has been given much study by investigators. Since the days of Spallanzani, who lived from 1729 to 1799, it has been known that domestic chickens and turkeys can hold grit in the gizzard for long periods. A recent experiment (Kaupp and Ivey, 1923) showed that the former can retain it for over a year. Grouse on gritless rations were experimented with roughly 30 years ago (Anonymous, 1912). It was concluded from these studies that game birds likewise can retain grit already in the gizzard in the absence of fresh supplies. A second British report to the same effect appeared a few years later (Macintyre, 1918). Similar findings in quail were reported from the United States about 10 years ago (Errington, 1931). The size and type of grits utilized by game birds of different species has been studied in England (Anonymous, 1937b) while the types, amounts and sizes of the materials utilized by pheasants have been the subject of investigation in this country (Dalke, 1938).

In most instances, it has been concluded that the function of grit was solely that of grinding agent in the gizzard. In this connection, however, the finding of grits in nestling birds (McAtee, 1905) still remains unexplained, while more recent experimentation (McCann, 1939) indicates that the ingestion of such materials may be conditioned by and primarily provide for certain mineral requirements, notably calcium, and that the mechanical function may be secondary importance.

The purpose of this phase of the current study was to determine whether or not it is absolutely necessary, or even desirable, to attempt to

furnish populations of wild game birds with supplies of grit during the winter months, particularly when the ground is covered with snow. This, of course, was irregardless of whether the function of grit may be mechanical, or nutritive, or both.

The two series of experiments previously described (pages 72 to 79) definitely have shown that bobwhite quail and ringneck pheasants can retain grit in the gizzard for periods lasting as long as six weeks. Also, though admittedly somewhat at variance with the findings of other investigators (Errington, *ibid.* and McCann, *ibid.*), it was found that both species could successfully withstand, without serious weight loss or any other discernable ill-effect, up to 10 weeks of winter weather without access to grit, feeding all the while only on dry weed seeds. It is reasonable to suppose that most other game birds are comparable in these respects to those forms utilized for experimentation.

Therefore, since it is only rarely, if ever, that all natural grit supplies over large areas are rendered completely unavailable by ice and snow for continuous periods of more than one week's duration, there appears to be no justification for the belief that it is necessary to furnish populations of wild birds with supplemental supplies of grit during the winter months.

Of Necessity for Water—The winter water requirements of birds and mammals on northern ranges have not been extensively studied. Though lack of water has been listed among the limiting characteristics of winter ranges (Edminster, 1941), it has been concluded that it is not an important factor in winter deer losses (Maynard, Bump, Darrow and Woodward, 1935). Reports for most other species do not appear in the literature.

The natural foods of the large game mammals usually contain relatively large percentages of water. The exact figures for various types of deer browse have been worked out by a number of different investigators. In Pennsylvania, this subject has been studied in unusual detail (Hellmers, 1940; and Forbes, Marcy, Voris and French, 1941). Many of the green foods taken by the smaller mammals and birds are likewise known to be of high moisture content, while dry grains and similar foods contain appreciable percentages of water (Morrison, 1939). Furthermore, it has long been known that the animal body is composed largely of water. Not only is such water released to the individual when the living tissues are destroyed to meet energy and maintenance requirements, but also the very oxidation of ingested foodstuffs produces water (Babcock, 1912; Newburgh and Johnston, 1930; and Maynard, 1937).

In addition to those points above mentioned, the fact that open water or snow is usually available must also be kept in mind. During those

unusually cold periods of relatively short duration when no snow and little open water are to be found, at least limited supplies of green foods relatively high in water content are invariably present. Thus, since the experiments herein described indicate that even the least hardy of the species studied, the bobwhite quail, can subsist on dry foods alone for a week or 10 days, it is concluded that lack of open water for drinking purposes is seldom, if ever, an important factor in winter losses of wildlife.

Of Effects of Temperatures and Air Movement—As previously pointed out (page 91), the importance of environmental temperature in winter losses of wildlife is generally recognized. The relative effects of different degrees of cold have, however, been measured in only a few instances (Giaja, 1925; Benedict and MacLeod, 1929; Riddle, Smith and Benedict, 1933; and Kendeigh, 1934). In the fasting studies herein reported, it was found (page 91) that, on the average, birds and mammals undergoing complete fasts survived only seven and one-third days (roughly 176 hours) at 0°F. with no wind as compared to just over nine days (about 216 hours) at a mean temperature of 40°F. also without air movement. Compared to the latter figure, the former represents a reduction of approximately 19% in survival time, accountable for on the basis of a 40°F. difference in environmental temperature.

In this connection, it is also of interest to know that current investigations being conducted by Roger M. Latham and the writer have shown that in some species, notably the whitetailed deer, relatively low but constant environmental temperatures do not produce nearly so great ill-effects as do widely fluctuating temperatures, particularly those running downward below the freezing point. For example, fawn deer were found to withstand constant temperatures of approximately 15°F. better than fluctuating temperatures running from 40°F. during the daylight hours to 20°F. during the night time. These findings are in accord with field observations made in Scotland on the red deer (Darling, 1937).

Except in the case of those species frequenting burrows, or dens, dug in the earth, or those utilizing hollows in trees or among rocks, for which shelters can be artificially constructed or indirectly furnished by encouraging the development of populations of digging animals such as the groundhog, little can be done to protect birds and mammals from the effects of low temperatures. Proper cover sometimes provides resting or roosting places slightly higher in temperature than the surrounding territory, but such thermal differences are usually too small to be of importance.

Also as heretofore stated, the effects of air movement in winter wildlife losses have received relatively little attention. The studies herein reported (page 93) have shown that at 0°F., the average survival period

of birds and mammals undergoing complete fasts was reduced almost 25% by subjecting the animals to constant air movements of only 5.8 m.p.h., as compared to those protected from the "wind." Comparable differences have similarly been shown among passerine species at higher temperatures (Kendeigh, 1934). Still more important is the fact that appreciably heavy losses of pheasants, as well as the deaths of lesser numbers of other species, in Iowa during the famed 1940 Armistice Day storm were attributed primarily to the high winds (maximum velocities of 50 m.p.h.) which accompanied the snow and low temperature (Scott and Baskett, 1941). These losses, involving ice formations about the head which frequently resulted in death from choking, were similar to others from the same state (Green and Beed, 1936), as well as from Minnesota (Fried, 1940).

Fortunately, in the case of losses such as those just described, preventive measures are possible. For the Iowa deaths last mentioned, it was concluded that the rate of mortality in pheasants was directly proportional to the distance of the birds from good protective cover (Green and Beed, *ibid.*). A more detailed report on winter pheasant survival in the same state (Green, 1938) indicates that the losses were highest in flocks which roosted in open cover and among those which were forced to range appreciable distances to secure feed. These facts would seem clearly to indicate that winter losses can be appreciably reduced through that comparatively simple expedient of management whereby evergreen, or some other form of wind-breaking cover, is provided in close proximity to available supplies of winter food. In many instances, this will not only reduce losses from exposure but also will cut down the kill by avian predators.

C. General

Study of the recorded winter losses of wildlife has clearly shown that in the Northern United States and Southern Canada, which is the region wherein the largest winter feeding campaigns are annually conducted, severe mortality from starvation is commonly encountered only among bobwhite quail. Even with this particular species, exposure, or exposure in combination with food shortages, doubtless causes far greater decimation than starvation, as in the case with most other avian forms. Also, the controlled experiments previously described and discussed indicate that, with the exception of the bobwhite, most forms can readily endure with few, if any, serious ill-effects those periods of food shortage and exposure normally accompanying winters of all but the greatest severity. The tests have further shown that constant supplies of grit are not essential to wintering game birds, while even appreciable losses in body weight brought about by exposure and shortages of high quality foods, do not necessarily react unfavorably on fecundity during the breeding season immediately following. In view of these facts, there appears to be, except

on very rare occasions, no actual need for furnishing wild birds and mammals with supplemental food supplies during the winter months, or, in other words, for winter feeding.

Regardless of the fact that it may be unnecessary, winter feeding will doubtless continue to be practiced in most of the northern states and southern provinces. Thus, it is in order to discuss briefly the advantages and the disadvantages of such activities.

Without question, the greatest advantage of winter feeding is represented by its educational value. One of the principal problems currently



Figure 18. A feeding rack of the type commonly used for deer.

faced in attempting to develop state- or country-wide programs aimed at the conservation of our natural resources is the development of widespread public interest in them. Because of that previously discussed "in-born urge to throw a crumb to the cold, starving birds and beasts," it is a comparatively simple matter, particularly during "spells" of extreme weather, to develop through newspaper articles, radio broadcasts and similar means a general interest in the plight of the "poor birds and animals." Once this spark has been fanned into a flame, it is relatively

easy to build up the fire and keep it burning. In other words, winter feeding provides a readily grasped at opportunity to satisfy a natural human instinct. Through the interest in birds and mammals which is so created, it is possible to develop in the minds of many persons a desire for greater knowledge of wildlife and the out-of-doors. This is the foundation upon which active cooperation in general conservation programs must be built. *Its value cannot be over-estimated.*

Another advantage of winter feeding is that it may at times be used as a means of temporarily holding birds, or mammals, in a given locality for some specific purpose. This is of particular value to the owners, or operators, of shooting preserves, whereon it is frequently desirable to "hold" abnormally high population densities of game for comparatively short periods of time for shooting purposes. Conversely, it is occasionally necessary to "feed game into" protected areas, such as refuges, to prevent its being taken by gunners.

Finally, *though such instances are comparatively rare and the population totals involved relatively small*, winter feeding can at times be successfully used to carry through the winter birds and mammals which would otherwise be lost.

Possibly the greatest disadvantage of the practice is its gross ineffectiveness. For example, large-scale quail feeding programs have long been carried on in many states (see page 12). Nonetheless, the occurrence of each winter of unusual severity invariably results in the winter-killing of a large percentage of the quail on the northern ranges. Here again the Pennsylvania records are of interest. During the winter of 1917-18 a comparatively large winter feeding program was in force. It did not, however, prove very effective in carrying the birds through the winter, as thousands of bobwhites died either of starvation or exposure, while the hunter's take fell off more than 50% the following fall, largely as a result of the previous winter's losses (see page 16). During the fall of 1935, the quail population of the Keystone State was at an unusually high level. The feeding activities during the winter of 1935-36 were far superior to those carried out in 1917-18. Though actual figures are not available, it is definitely known that far more people participated in the program in 1935-36 than in 1917-18. Also, an improved highway system enabled better coverage in the later season, while a record expenditure for food was made by the Commission during the year (see Table 1). Regardless of these facts, the severe winter took an unusually heavy toll. On one study area *where constant feeding was carried on over 90% of a population of approximately 175 birds was lost* (Gerstell, 1937b), while it is generally believed that more than 80% of all birds within the State

succumbed. It may by some be argued that winter feeding was responsible for the survival of the few birds remaining in the spring of 1936, but of the living, the percentages of "fed" and "unfed" individuals will never be known. Doubtless similar occurrences, indicative of ineffective programs, have been observed in a number of other states.

In this connection, it may be well to call attention to the fact that unbelievably favorable results appear frequently to be ascribed to winter feeding activities. For example, during February, 1934, an unusually large population of ducks was present in the vicinity of New York City. Undoubtedly, a number of them were suffering from the severe weather, from possible food shortages, from oil-soaking of the feathers, from old gunshot wounds, from parasites or from other causes. Grouped on the ice at the edge of open water, however, they were soon noticed and their plight promptly attributed to starvation. Publicized in the large, metropolitan newspapers, this soon resulted in great public concern for the birds. In response to urgent demands that something be done to alleviate the situation, several tons of corn were shortly provided for feed. Written up in one of the ornithological periodicals, it was said that the prompt feeding of several tons of corn had saved the lives of 200,000 ducks on the brink of starvation (Anonymous, 1934). Obviously, 6,000 pounds of corn, representing an average of 0.03 pounds per birds, could hardly have prevented the death of 200,000 ducks on the verge of starvation.

A second disadvantage of winter feeding is the inefficiency of the different systems necessarily followed in the work. For example, in recent years, the Pennsylvania Game Commission has annually planted in a number of the south-central counties many winter food plots specifically for wild turkeys. Field investigations, however, have revealed the fact that over 90% of their total production has been devoured by deer during the late summer and early fall, long before it was required by the turkeys. True may it be that this was largely the result of an excessive deer population, but even supposing grains had been fed in "deer-proof" dispensers, large portions of it would have been taken by undesirable species such as mice, rats and crows. Similarly, plots planted for pheasants have been completely utilized in early fall by blackbirds. Naturally, consumption by song birds, squirrels, rabbits and the like cannot be considered as waste, but the plantings nonetheless have failed under such conditions to meet the purpose for which they were established. Needless to say, waste from emergency feeding, whereby grain is scattered in places believed to be frequented by game, often amounts to almost total loss.

Thirdly, large scale feeding programs are invariably impractical. For example, investigation (Hawkins, 1937) has shown that under average

winter conditions, certain game species weekly consume the following amounts of artificial foods supplied at feeding stations: Ringneck pheasant, 2.0 pounds; Hungarian partridge, 1.0 pound; bobwhite quail, 0.5 pound; and cottontail rabbit, 1.0 pound or slightly more. Even granting that these figures might fall off considerably during mild periods and that it might be necessary to feed only for six weeks each winter, the difficulties encountered in attempting to provide by this means nourishment for even a portion of a major species population may readily be



Figure 19. This undernourished whitetail fawn, born the previous summer, gorged itself at a feeding shelter only to perish in agony within a few hours.

visualized. Let it be assumed, as might easily be the case in one of the prairie states, that there is a total pheasant population of 1,000,000 individuals, with an average density of 50 birds per square mile. This would mean that they would probably be spread over an area of more than 15,000 square miles. To feed only half of them for one week would require, using for computation not the above figure but that for captive pheasants which is only one-quarter as great (see Table XXI), roughly 125 tons of feed. To arrange a sound distribution of this amount of food over even 7,500 square miles, particularly during severe weather,

succumbed. It may by some be argued that winter feeding was responsible for the survival of the few birds remaining in the spring of 1936, but of the living, the percentages of "fed" and "unfed" individuals will never be known. Doubtless similar occurrences, indicative of ineffective programs, have been observed in a number of other states.

In this connection, it may be well to call attention to the fact that unbelievably favorable results appear frequently to be ascribed to winter feeding activities. For example, during February, 1934, an unusually large population of ducks was present in the vicinity of New York City. Undoubtedly, a number of them were suffering from the severe weather, from possible food shortages, from oil-soaking of the feathers, from old gunshot wounds, from parasites or from other causes. Grouped on the ice at the edge of open water, however, they were soon noticed and their plight promptly attributed to starvation. Publicized in the large, metropolitan newspapers, this soon resulted in great public concern for the birds. In response to urgent demands that something be done to alleviate the situation, several tons of corn were shortly provided for feed. Written up in one of the ornithological periodicals, it was said that the prompt feeding of several tons of corn had saved the lives of 200,000 ducks on the brink of starvation (Anonymous, 1934). Obviously, 6,000 pounds of corn, representing an average of 0.03 pounds per birds, could hardly have prevented the death of 200,000 ducks on the verge of starvation.

A second disadvantage of winter feeding is the inefficiency of the different systems necessarily followed in the work. For example, in recent years, the Pennsylvania Game Commission has annually planted in a number of the south-central counties many winter food plots specifically for wild turkeys. Field investigations, however, have revealed the fact that over 90% of their total production has been devoured by deer during the late summer and early fall, long before it was required by the turkeys. True may it be that this was largely the result of an excessive deer population, but even supposing grains had been fed in "deer-proof" dispensers, large portions of it would have been taken by undesirable species such as mice, rats and crows. Similarly, plots planted for pheasants have been completely utilized in early fall by blackbirds. Naturally, consumption by song birds, squirrels, rabbits and the like cannot be considered as waste, but the plantings nonetheless have failed under such conditions to meet the purpose for which they were established. Needless to say, waste from emergency feeding, whereby grain is scattered in places believed to be frequented by game, often amounts to almost total loss.

Thirdly, large scale feeding programs are invariably impractical. For example, investigation (Hawkins, 1937) has shown that under average

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appears not only impractical but under actual conditions probably impossible. Similarly, let us consider a portion of a deer herd suffering from malnutrition as a result of over-browsed range conditions. (Artificial feeding is frequently recommended as a solution for such problems.) There might conceivably be 250,000 undernourished individuals scattered over 10,000 square miles of forest. Assuming their average weight to approximate 100 pounds each, experiments (Nichol, 1938, Gerstell, 1938a; and Davenport, 1939) indicate that the daily food requirements of the group would exceed 500,000 pounds, or 250 tons. To attempt to supply and distribute such amounts over a period of even one week would, of course, be highly impractical.

A fourth disadvantage of winter feeding is related to the dangers involved. The practice quite frequently leads not only to excessive population concentrations but also to abnormal behavior of the animals. Such crowding together of individuals all feeding on the same ground represents a potential disease source which cannot be disregarded. Furthermore, at least under certain conditions, emergency feeding may even prove harmful rather than beneficial to the animals so nourished. For example, the writer has observed that providing undernourished deer in late winter with alfalfa, corn and similar highly nutritious foods of types to which they are not accustomed frequently results in the death of many of the individuals so fed. In some instances, post mortem examinations indicated that the animals possibly had so rapidly eaten such large amounts of alfalfa that the material became "balled up" in the stomachs, causing complete, mechanical stoppage of the intestinal tract. In others, the nutrients were observed to result in severe scours, terminating in death within a few days. Doubtless these losses are similar to those frequently suffered by sheep (Morrison, 1939). Still another danger lies in the possibility of changing the feeding habits of some species to such an extent that, like the elk in Jackson Hole, they might become almost entirely dependent upon man as a source of food supply.

Still another undesirable effect frequently produced by winter feeding is that it tends to reduce the wildness, and hence the sporting value, of some species. This varies widely among the different types of birds and mammals, but in practical wildlife management any factor which tends toward even partial domestication should under almost all circumstances be carefully avoided if at all possible.

All in all, it appears obvious that, except for public relations purposes, the advantages of winter feeding are far more than outweighed by its disadvantages. This, even combined with the fact that there is little actual need for providing wild animals with supplemental food supplies

during the winter months, however, does not necessarily mean that the practice should be immediately eliminated in its entirety from the field of practical wildlife management, but rather that it should be revised and utilized to its greatest possible advantage, probably somewhat along the lines outlined in the paragraphs immediately following.

In the first place, it will doubtless prove sound to work as rapidly as possible toward all but complete elimination of emergency feeding in-



Figure 20. A game food and cover plot in early fall.

volving the scattering of food during periods of severe weather in places where game is believed most likely to find and to utilize it. That such action may under some peculiar circumstances prove advantageous is conceivable, but it is felt that such conditions will only very rarely be encountered.

Secondly, because of their expense and inefficiency, the widespread and indiscriminate use of feeding shelters should be discouraged. They should probably be established and operated only where it can be shown that there is a definite need for them and that they will most effectively serve a specific purpose.

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Thirdly, the present-day conception of food plot mixtures as plantings designed solely to furnish game birds and mammals with supplemental food supplies during late winter appears badly in need of alteration. To continue blindly along the lines commonly followed in this connection during recent years seems certain to result only in what may later come to be considered one of wildlife management's most colossal blunders. On the other hand, it would appear that with certain changes, what is now generally considered a winter food plot, may well be made an important and highly valuable tool of management. This will mean that the seed mixture will have to be changed in make-up so as to produce a *combined patch of food and cover* which will furnish both nourishment and shelter from late summer through until spring. As such, it will prove of value only under particular conditions. Thus, its general use by private individuals, sportsmen and others may not prove wise unless guided by trained personnel fully capable of directing such work.

Finally, the phase of winter feeding upon which major emphasis should be placed most likely will prove to be that concerned with the provision of additional, *permanent* sources of natural foods, particularly on areas definitely failing to meet the essential requirements for proper nourishment. Certainly these activities will involve, among other things, the planting of nut trees, fruiting shrubs and other plants.

In the conduction of the program, those educational opportunities which may be exposed through the satisfaction of an instinctive, human urge to provide winter food for wild birds and mammals should by all means be fully utilized.

PART IV—SUMMARY AND CONCLUSIONS

A. Summary

Winter feeding has been defined as the act of providing wild birds and mammals with supplemental food supplies during the winter months. By using Pennsylvania records as a typical example, the history and development of the practice in the Northern United States and Southern Canada has been traced. The various methods followed in each phase of the work have been briefly outlined. Furthermore, data designed to provide some conception of the number of persons annually participating in such activities, as well as the amounts of time, effort and money expended therein, have been presented.

In an attempt to determine the actual need for winter feeding, the ornithological and mammalian literature was first searched for reports of winter losses of wildlife, particularly from starvation. Approximately 75 references, concerned with more than 35 game and 40 other species, have been cited and discussed. Secondly, a number of controlled experiments, performed both in the laboratory and out-of-doors, were conducted and have been reported on. These included a series of fasting tests involving over 200 individuals of 15 avian and mammalian forms. In relation thereto, the literature on fasting and the factors affecting such powers has been briefly reviewed. In addition, the grit and water requirements of game, together with the relationship between food shortages and fecundity, were investigated, while the effects of air movement on fasting animals also were studied.

Finally, the history and status, the actual need for, and the advantages and disadvantages of winter feeding, as well as possible lines of future action, have been discussed in detail.

B. Conclusions

With reference to the vast amounts of time, effort and money annually expended by large numbers of persons in the Northern United States and Southern Canada for the winter feeding of wildlife, it is, as a result of the studies herein reported, concluded:

- I. That the basis which has allowed for the development of large-scale winter feeding programs is composed of two principal components, namely,
 - A. An instinctive urge, common to a large percentage of all humans, to provide animals observed during severe weather with food; and
 - B. A general, though inexplicable and indefensible, belief that shootable game crops can annually be produced only through the provision of supplemental winter food supplies.

- II. That the normal stages in the evolution of any such programs are three in number, namely,
 - A. Emergency Feeding;
 - B. Shelter construction and operation; and
 - C. Food plot planting.
- III. That there exists, nonetheless, little, if any, actual need for winter feeding, because
 - A. A survey of past records indicates
 1. That most winter wildlife losses are from causes other than starvation, and
 2. That the bobwhite quail is the only species which suffers serious decimation because of the lack of winter foods; while
 - B. Experiments conducted have shown
 1. That ringneck pheasants are unusually hardy birds capable of enduring without serious ill-effects complete fasts of two or more weeks during severe winter weather,
 2. That ruffed grouse are vigorous birds among which serious losses from cold and hunger can rarely be expected,
 3. That wild turkeys suffer little from a week of cold weather and no food,
 4. That Hungarian and chukar partridges can readily withstand cold and lack of food over periods of five or six days,
 5. That bobwhite quail are highly susceptible to nutritive shortages and to cold, while their ability to resist both is largely dependent upon covey size,
 6. That mallard ducks can undergo without serious difficulty a week, or even 10 days, of low temperature in combination with limited food supplies,
 7. That great horned owls and red-shouldered hawks are little affected by a winter week without food,
 8. That whitetailed deer succumb to malnutrition only after a relatively long period of days, or even weeks,
 9. That cottontail rabbits provided with adequate cover rarely suffer greatly from cold or lack of food,
 10. That grey, and probably red, foxes can in winter survive without food for a week or 10 days with little difficulty,
 11. That muskrats are highly susceptible to lack of nourishment and exposure to low temperatures, but that they probably suffer severe losses only when forced to leave their houses and forage extensively in severe weather,

12. That skunks are highly resistant to food shortages and cold and not subject to winter losses,
 13. That opossums suffer very little when faced with a week of severe weather and scarcity of food,
 14. That winter food shortages may adversely react upon the reproductive powers of some species, such as the bobwhite quail, but in the case of others, including ringneck pheasants and mallard ducks, no such relationship appears to exist,
 15. That mature ringneck pheasants and bobwhite quail, and probably other gallinaceous birds, are able not only to retain grit in the gizzard for six weeks or more, but also in the absence of additional supplies to subsist without ill effects for two months or more,
 16. That lack of drinking water in the liquid form is not an important factor in winter losses of wildlife,
 17. And, finally, that air movement in the form of wind exerts a major influence over the survival powers of birds and mammals exposed to low environmental temperatures.
- IV. That, as presently carried out, the disadvantages of winter feeding, particularly its ineffectiveness and its inefficiency, outweigh its advantages.
 - V. And, therefore, that in the future, emergency feeding should be practically eliminated, the construction and operation of feeding shelters severely curtailed, the food plot altered to provide both nutrients and cover through both fall and winter under a plan of restricted, special use, while emphasis is placed on the provision of permanent sources of natural foods, particularly on areas now lacking the essential requirements of proper nourishment, at all times taking full advantage of every opportunity to encourage greater participation in wildlife conservation through the interest which may be shown in winter feeding.

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